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SPECIAL ARTICLES

THE COCONUT, ITS CULTURE AND USES

By P. J. Wester

Agricultural Advisor, Department of Mindanao and Sulu

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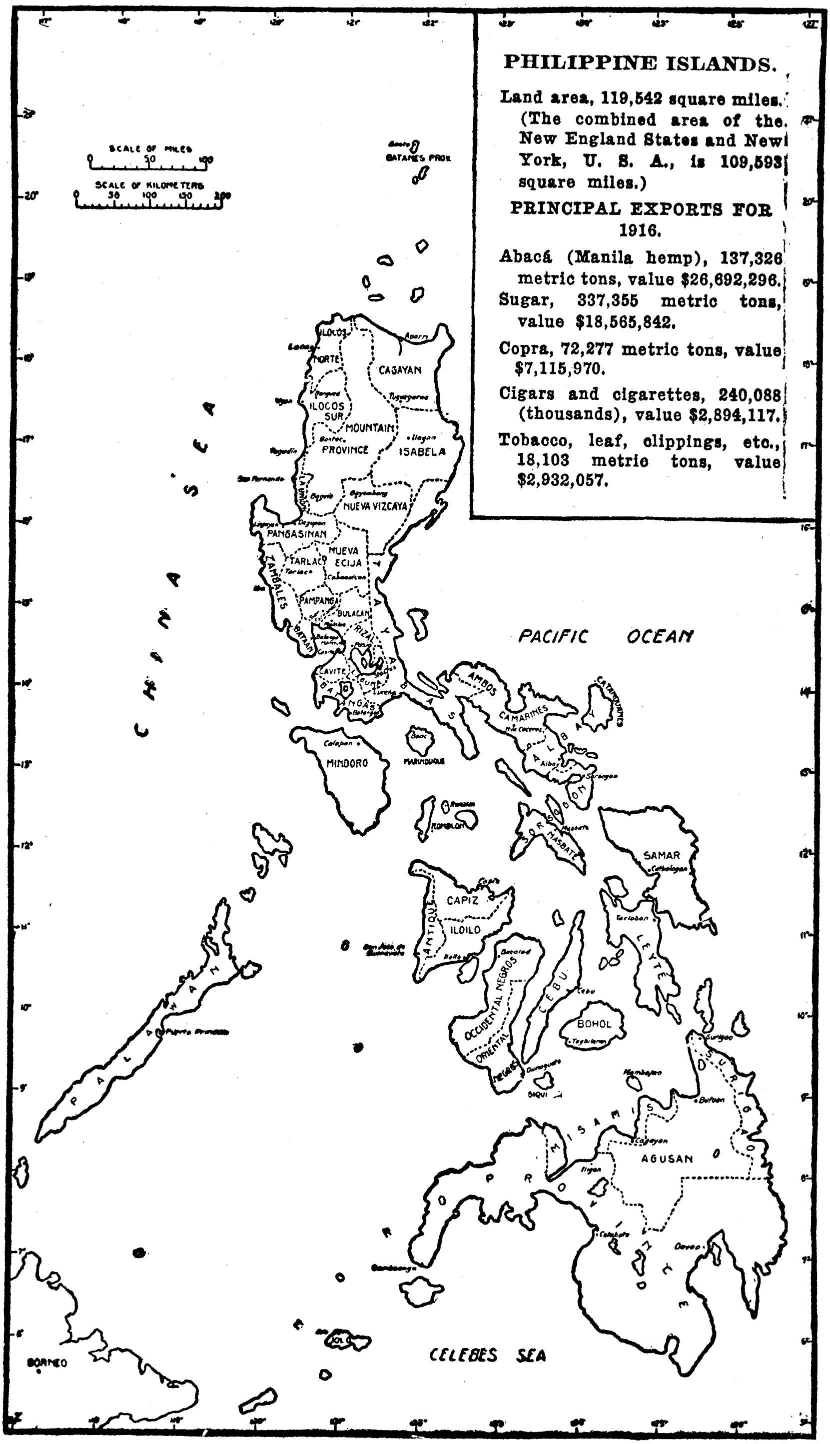
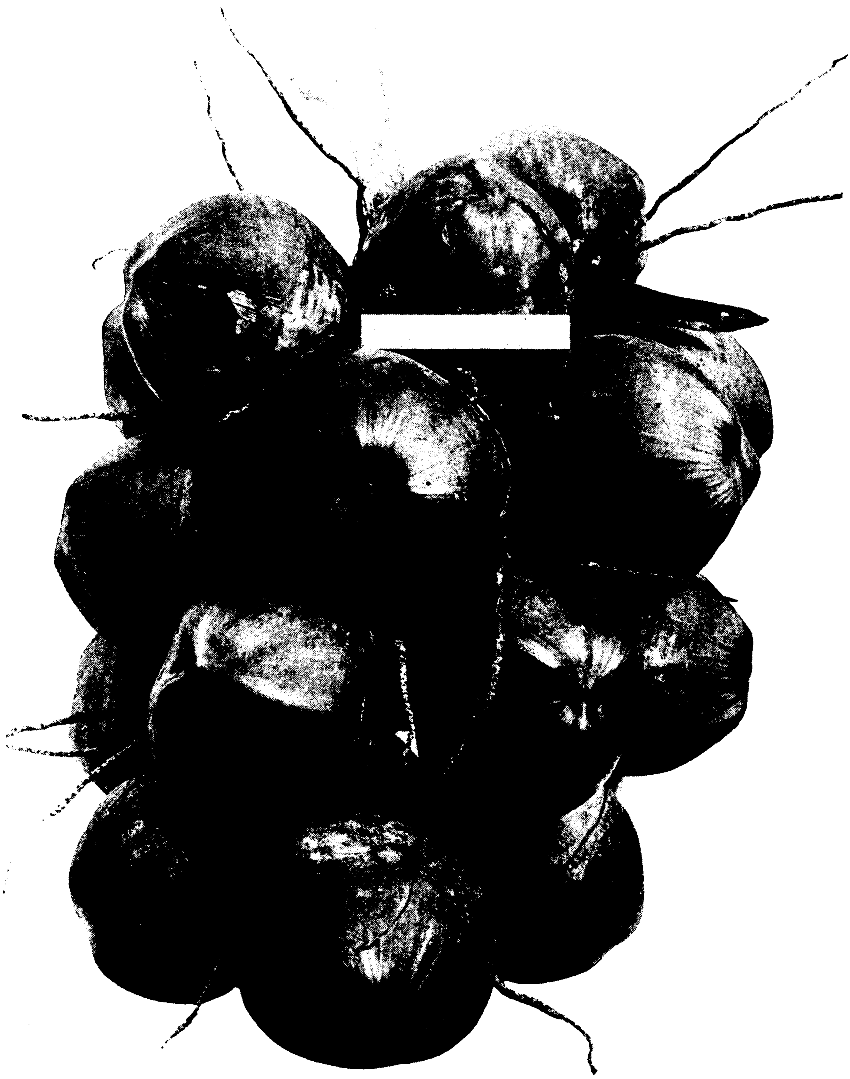

PHILIPPINE ISLANDS.
Land area, 119,542 square miles. (The combined area of the New England States and New York, U. S. A., is 109,593 square miles.)
PRINCIPAL EXPORTS FOR 1916.
Abacá (Manila hemp), 137,326 metric tons, value $26,692,296.
Sugar, 337,355 metric tons, value $18,565,842.
Copra, 72,277 metric tons, value $7,115,970.
Cigars and cigarettes, 240,088 (thousands), value $2,894,117.
Tobacco, leaf, clippings, etc., 18,103 metric tons, value $2,932,057.
SCALE OF MILES
SCALE OF KILOMETERS
BATANES PROV.
CHINA SEA
PACIFIC OCEAN
CELEBES SEA
ILOCOS NORTE
CAGAYAN
ILOCOS SUR
MOUNTAIN PROVINCE
ISABELA
LA UNION
NUEVA VIZCAYA
PANGASINAN
NUEVA ECIJA
TARLAC
ZAMBALES
PAMPANGA
BULACAN
BATAAN
RIZAL
CAVITE
BATANGAS
TAYABAS
AMBOS CAMARINES
CATANDUANES
ALBAY
SORSOGON
MINDORO
MARINDUQUE
ROMBLON
MASBATE
SAMAR
CAPIZ
ANTIQUE
ILOILO
OCCIDENTAL NEGROS
ORIENTAL NEGROS
CEBU
BOHOL
LEYTE
SIQUIJOR
PALAWAN
SURIGAO
MISAMIS
AGUSAN
MORO PROVINCE
BORNEO



A bunch of coconuts.

THE PHILIPPINE

Agricultural Review

VOL. XI FIRST QUARTER, 1918 No. 1

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EDITORIAL.

Among the major plant industries of the tropics, sugar cane is one of the oldest and rubber is the latest addition to the more important crops. While copra "arrived" somewhat earlier than rubber, it seems but yesterday when the coconut palm was associated chiefly with tales of shipwrecked adventurers, and pirates, and the cannibals of the South Seas. But nothing is sacred in these prosaic days and among other more or less romantic objects the coconut palm has also been pressed into service.

Even before the beginning of the agricultural era of the coconut, this tree was quite extensively planted by the Filipinos; hence the Philippines were in excellent position to profit by the rapidly increasing world's demand for copra from the very beginning of the copra trade. From thence to coconut growing on a commercial basis was but a step. In the value of the output of coconut products, also, the Philippines closely approximates that of Ceylon, outranking all other countries except the Dutch East Indies and the Federated Malay States.

Following the lead of other great coconut countries, such as Java and Ceylon, the Philippines have, within the last few years, seen the installation of several coconut oil mills of varying capacities, one of which, in the perfection of its appointment and in the excellence of its product, is probably equal if not superior to all other oil mills in the Orient.

.When we consider that the island of Ceylon, with an area of about 25,000 square miles, aside from its great tea, rubber and other exports, having no greater advantages in soil and climate, yet equals the Philippines in the value of her coconut exports, which islands total 119,000 square miles, the islands of Luzon and Mindanao exceeding 40,000 and 36,000 square miles in area respectively, there would appear to be ample justification for the optimism displayed by the biggest planters in the Philippines relative to the future great expansion of the coconut industry in the Philippine Archipelago.

THE COCONUT, ITS CULTURE AND USES.

[By P. J. WESTER, *Agricultural Advisor, Department of Mindanao and Sulu.*]

INTRODUCTION.

While it is probably true that the coconut has played a more or less important part in human history since its food value was first discovered, an event that must have occurred at a very remote date, while it is frequently mentioned by the early explorers and writers on botany, while its habitat has long been cosmopolitan, and its uses have been many to the various people inhabiting the tropics of both hemispheres, the importance of the coconut in the world's trade is of recent date.

The coconut has of course been employed as a food by the native inhabitants in all countries since its introduction. In the trade it first became preëminent as an illuminant and for its employment in soap manufacture, but the elevation of the coconut palm to its present-day importance in tropical agriculture is due to the discovery about 30 years ago of the feasibility of the manufacture of vegetable butter and other edible related products from the oil and the dried nut, usually referred to as copra. Coconut oil is also an ingredient in many toilet articles, such as cremes and pomades, etc.

In the Insular markets the coconut occupied second place in 1917 among the agricultural industries of the Philippines, and with a total of ₱39,468,595 [1] worth of copra and coconut oil exported it ranked third in our export trade. Approximately one-third of the world's production of copra is of Philippine origin.

The following tables give a survey of the growth of the coconut industry of the Philippine Islands:

---

[1] ₱1.00 (Philippine Currency) equals $0.50 (United States Currency).

TABLE I.—*Coconut planting and production in the Philippines, 1916.*

Rank.	Provinces.	Trees.	Nuts gathered.	Nuts consumed for food.	Copra.	Oil produced.	Tuba produced.	Total value of coconut products in the municipal markets.				All values.
								Nut.	Copra.	Oil.	Tuba.	
		Number.	*Number.*	*Number.*	*Kilos.*	*Liters.*	*Liters.*					
4	Albay	3,860,990	60,258,564	8,121,765	10,103,430	557,685	2,480,214	₱317,084.55	₱1,458,856.18	₱106,574.95	₱46,521.52	₱1,929,037.20
7	Ambos Camarines	2,661,841	44,552,446	3,455,064	8,364.890	210,843	259,566	143,611.25	1,108,724.79	58,608.10	27,939.82	1,338,883.96
24	Antique	361,996	789,062	248,127	120,030	8,093	417,773	6,043.52	14,568.52	1,669.70	36,237.40	58,519.14
32	Bataan	23,004	17,593	17,593				1,004.60				1,004.60
29	Batanes	21,960	70,676	20,552	4,567	2,875		1,005.56	319.69	718.75		2,044.00
18	Batangas	435,267	4,498,690	249,590	886,247			9,625.80	127,785.52			137,411.32
11	Bohol	2,051,913	28,080,766	2,812,733	5,452,926	91,104	3,658,235	87,231.93	852,238.74	22,967.66	183,148.43	1,145,586.76
31	Bulacan	18,846	18,900	18,900				1,080.00				1,080.00
25	Cagayan	143,690	570,589	570,589		104		18,981.17		31.20		19,012.37
10	Capiz	3,233,006	28,389,509	2,111,971	4,823,530	144,554	1,797,411	41,448.86	649,300.99	21,804.80	96,547.75	809,102.40
22	Cavite	157,989	1,036,560	595,460	106,775			25,547.00	16,016.25			41,563.25
6	Cebu	3,878,688	44,763,687	7,082,576	7,970,594	251,309	20,524,902	279,303.77	1,299,407.30	73,508.92	943,036.53	2,595,256.52
28	Ilocos Norte	41,500	194,324	194,324				11,577.39				11,577.39
27	Ilocos Sur	76,860	214,951	155,560	7,051	2,441		8,140.52	762.60	379.30		9,282.42
17	Iloilo	1,036,301	5,820,532	1,765,847	789,020	22,758	4,872,226	69,340.33	100,839.64	7,020.05	207,110.69	384,310.71
33	Isabela	2,297	17,330	7,380		975		1,508.00		292.50		1,800.50
2	Laguna	4,919,924	85,919,088	7,033,833	15,710,508	802,532	2,726,486	214,107.04	2,096,021.18	237,377.98	60,428.32	2,607,934.52
21	La Union	126,841	1,283,278	641,048	110,234	17,900		26,197.43	18,019.79	4,964.95		49,182.17
9	Leyte	2,435,691	29,869,058	5,578,456	4,845,983	261,188	4,414,166	188,991.85	592,437.79	96,250.30	268,616.82	1,146,296.76
3	Mindanao & Sulú	4,667,509	78,951,220	4,180,348	14,194,902	13,354	547,737	101,194.54	2,067,539.27	5,608.70	27,675.35	2,202,017.86
20	Mindoro	740,404	3,772,265	612,966	645,560	385	190,238	14,563.92	77,478.30	74.50	10,116.90	102,233.62
5	Misamis	3,675,591	49,176,760	347,180	10,895,581	12,851	848,745	9,239.67	1,303,055.87	2,554.10	46,198.06	1,361,047.70
34	Mountain	10,139	12,673	9,140		457		365.04		118.05		483.09
30	Nueva Ecija	16,851	25,989	25,989				2,124.53				2,124.53
35	Nueva Vizcaya	10,515	9,297	4,790		491		598.00		322.60		920.60
16	Occidental Negros	810,703	8,511,028	1,606,251	1,471,660	1,640	3,010,242	62,803.17	165,382.12	275.02	190,304.33	418,764.64
13	Oriental Negros	1,509,862	20,830,047	496,749	4,395,289	2,195	983,114	14,393.92	596,482.90	429.29	50,368.70	661,674.81
19	Palawan	216,227	4,359,651	419,979	932,329	1,675	342,828	10,349.58	106,681.31	255.00	22,252.85	139,538.74
	Pampanga											
15	Pangasinan	900,482	10,542,114	1,446,978	1,942,598	120,557	38	46,511.57	247,997.32	35,825.35	7.60	330,341.84
36	Rizal	30,993	150	150				7.50				7.50
8	Samar	3,827,806	43,878,423	5,585,485	8,822,611	10,161	2,794,764	217,007.49	869,387.71	7,841.66	109,335.00	1,203,571.86
12	Sorsogon	1,826,324	26,654,723	2,488,811	5,506,747	29,134	196,916	85,146.40	702,292.49	5,828.10	13,823.36	807,090.35
14	Surigao	631,078	16,720,807	1,937,665	2,242,354	3,330	3,349,833	49,795.86	490,093.56	754.80	148,289.01	688,933.23
26	Tarlac	41,807	215,643	201,304		1,061		11,730.64		265.25		11,995.89
1	Tayabas	9,545,079	134,424,517	3,320,920	31,341,323	116,243	508,678	84,674.24	4,043,498.55	20,866.52	35,544.90	4,184,584.21
23	Zambales	203,873	824,841	452,333	77,454	410	14,500	15,006.79	10,907.16	100.00	725.00	26,738.95
	Total	54,153,847	735,275,751	63,818,406	141,764,193	2,688,305	53,938,612	2,177,343.43	19,016,095.54	713,288.10	2,524,228.34	24,430,955.41

Classification of coconut trees (estimated):	
Tuba trees producing one liter of tuba for six months	299,103
Trees too young to bear fruit	24,133,909
Bearing trees averaging 25 nuts per tree annually	29,720,835
Total number of coconut trees	54,153,847
Classification of the nuts:	
Nuts consumed for food	63,818,406
Estimated nuts used for copra [a]	644,574,295
Estimated nuts used for oil [b]	26,883,050
Total nuts gathered	735,275,751

[a] Average of 4.5 nuts to make one kilo of copra.
[b] Average of 10 nuts to make one liter of oil.

NOTE.—If the average distance between coconut trees be considered as 8 meters (26.2 feet) the number of trees per hectare would be 156 and the entire area cultivated would be 347,140 hectares.

If the average distance between coconut trees be considered as 7.07 meters (23.2 feet) the number of trees per hectare would be 200 and the entire area cultivated will be 270,769 hectares. The area of 270,769 hectares is probably the more exact of the areas mentioned. It represents the entire area of land in the Philippine Islands which is estimated to be devoted to the cultivation of coconut trees.

TABLE II.—*Coconut Planting and Production in the Philippines.*

Years ending June 30.	Trees planted.	Production.	Value.
1910	32,838,544	161,609,148 nuts used for food	₱4,548,274.44
		118,140,822 kilos of copra	17,721,123.30
		6,993,513 liters of oil	2,098,053.90
		35,883,540 liters of tuba	1,794,177.00
1911	41,695,165	154,980,726 nuts used for food	4,649,421.78
		118,323,114 kilos of copra	17,748,467.10
		6,602,966 liters of oil	1,980,889.80
		37,649,880 liters of tuba	1,882,494.00
1912	46,136,349	96,262,490 nuts used for food	2,887,874.70
		174,035,835 kilos of copra	29,586,091.95
		4,868,101 liters of oil	1,460,430.30
		39,842,911 liters of tuba	1,992,145.55
1913	44,642,411	147,981,014 nuts used for food	5,919,240.56
		116,699,818 kilos of copra	21,005,967.24
		5,010,540 liters of oil	1,503,162.00
		42,145,874 liters of tuba	2,107,293.70
1914	49,190,368	63,057,700 nuts used for food	2,520,160.66
		107,382,931 kilos of copra	17,385,087.79
		3,595,332 liters of oil	1,225,412.86
		54,048,393 liters of tuba	3,521,102.72
1915	52,795,261	72,441,087 nuts used for food	2,097,879.36
		171,573,963 kilos of copra	18,377,184.24
		3,175,626 liters of oil	662,491.19
		51,372,213 liters of tuba	3,324,329.23
1916	54,153,847	63,818,406 nuts used for food	2,177,343.43
		141,764,193 kilos of copra	19,016,095.54
		2,688,305 liters of oil	713,288.10
		53,938,612 liters of tuba	2,524,228.34

NOTE.—It is estimated that the average number of coconut trees planted to the hectare is 200 trees.

The production of coconut oil included in this statement representes oil made for local consumption by Filipinos from coconuts in their homes.

TABLE III.—*Copra and coconut exports of the Philippines.*

Year.	Copra.		Coconut oil.	
	Amount.	Value.	Amount.	Value.
	Kilos.		*Kilos.*	
1910	115,284,851	₱18,307,902		
1911	115,602,012	19,798,914		
1912	169,342,476	33,029,498		
1913	113,055,063	23,295,796	1,302,275	₱625,026
1914	71,522,281	16,594,858	8,478,369	3,993,296
1915	148,756,617	24,789,424	13,253,533	5,453,028
1916	79,341,823	13,066,530	13,598,432	5,976,322

These figures eloquently illustrate the importance of the coconut industry in the Philippines.

TABLE IV.—*Coconut production and consumption according to countries.*

[Figures compiled from official returns of the various countries for 1913, as nearly as

	Imports.					
	Coconuts.		Copra.		Coconut oil.	
	Number.	*Pesos.*	*Kilos.*	*Pesos.*	*Kilos.*	*Pesos.*
Consuming countries—total		4,609,622	635,437,131	182,364,818	126,541,159	53,592,850
1. Germany			196,597,800	58,038,204	594,400	269,892
2. France			123,359,800	34,998,408		
3. Netherlands			100,634,877	29,127,760	16,685,501	6,707,572
4. Russia			67,521,055	19,902,314	402,273	183,324
5. Denmark	[a]35,500	5,360	33,686,500	9,750,376	6,649,700	3,225,648
6. Austria-Hungary			33,604,700	9,550,456	1,000	454
7. United Kingdom			31,361,888	8,727,650	59,412,784	25,877,274
8. United States	(b)	4,266,832	20,605,750	4,790,026	33,734,148	13,407,884
9. Belgium	[a]339,435	38,720	19,552,024	5,754,650	3,833,896	1,664,870
10. Australia	[a]277,876	24,226	5,954,420	1,280,552	6,066	3,688
11. Japan			2,558,170	444,384	492,464	145,286
12. Italy	[a]90,000	13,896			3,993,300	1,695,556
13. South Africa	(b)	25,258			635,191	344,324
14. Canada	4,057,737	235,330	147	38	100,436	67,078
Producing countries—total		373,120	106,663,792	20,406,092	7,981,182	2,818,398
15. Dutch East Indies	45,500	1,830	646.105	103,894	5,274,328	1,794,446
16. Straits Settlements	(b)	5,702	104,899,500	20,121,530	1,139,400	430,524
17. Philippine Islands						
18. Ceylon	17,288	466	377,596	48,840	813	534
19. British India	9,280,771	315,476	16,612	4,000	103,200	48,480
20. New Guinea, etc. (German)						
21. Samoa (German)						
22. Zanzibar						
23. Federated Malay States					1,323,060	495,530
24. French Oceania			216,276	15,028		
25. Fiji						
26. Carolines, etc						
27. Solomon Islands (British)						
28. French Indo-China	[a]190	8				
29. German East Africa						
30. Tonga						
31. New Caledonia			282,544	56,686		
32. Seychelles						
33. Tutuila						
34. New Zealand	1,140	88	221,488	55,332		
35. Guam						
36. British North Borneo						
37. Gold Coast						
38. Trinidad and Tobago	474,781	25,024	3,191	730	34,864	14,172
39. Dahomey	[a]182,712	3,526	480	52		
40. Togo						
41. Sarawak						
42. Santo Domingo						
43. British Guiana						
44. Jamaica					1,241	682
45. Porto Rico						
46. Panama						
47. British Honduras	406,546	19,398				
48. Cuba						
49. Mexico						
50. Nicaragua						
51. Costa Rica					8,862	4,076
52. Brazil						
53. Venezuela						
54. Mauritius						
55. British East Africa						
56. Senegal	24,020	1,390				
57. French Guinea	[a]1,249	112				
58. Ivory Coast						
59. Gabon						
60. Reunion					20,890	7,882
61. Madagascar						
62. French Somali Coast	[a]215	22				
63. French Colonies in India					73,682	21,584
64. Guadeloupe						
65. French Guiana	[a]1,018	78			842	488

[a] Coconut quantities marked thus ([a]) are kilos.

International trade in coconuts, copra, and coconut oil, calendar year 1913.
available, and designed to show normal trade conditions prior to the European war.]

Exports.						Calendar year.	Remarks.
Coconuts.		Copra.		Coconut oil.			
Number.	*Pesos.*	*Kilos.*	*Pesos.*	*Kilos.*	*Pesos.*		
----------	14,188	121,001,391	34,792,662	50,022,932	20,943,590	------	
----------	----------	657,800	174,216	24,876,000	10,528,644	1913	
----------	----------	11,032,300	3,136,602	----------	----------	1913	
----------	----------	82,355,778	23,837,056	5,375,748	2,161,050	1913	
----------	----------	----------	----------	----------	----------	1913	
[a] 800	----------	2,542,000	763,264	6,393,600	2,570,656	1913	
----------	----------	----------	----------	199,400	100,386	1913	
----------	----------	16,930,624	4,686,820	9,828,378	4,156,040	1913	
(b)	13,270	----------	----------	245,938	118,442	1913-14	Year ending June 30.[b]
----------	----------	6,957,363	2,047,726	1,094,590	475,326	1913	
[a] 2,337	856	525,526	146,978	2,008,378	832,678	1913	
----------	----------	----------	----------	----------	----------	1913	
[a] 400	62	----------	----------	900	368	1913	
----------	----------	----------	----------	----------	----------	1913	
----------	----------	----------	----------	----------	----------	1913-14	Year ending March 31. Imports of coconut oil, edible coconut oil only.
----------	5,540,882	619,018,711	128,358,698	45,481,971	17,927,964	------	
34,302	1,378	229,339,195	44,253,292	1,510,017	540,780	1913	
(b)	214,594	116,694,960	22,998,250	7,181,580	2,634,292	1914	
153,460	11,564	82,219,363	19,091,448	5,010,429	2,292,678	1913	
16,861,324	902,710	56,758,434	13,598,372	27,786,787	10,859,426	1913	
344,111	14,764	38,802,666	10,120,626	3,711,022	1,509,326	1913-14	Year ending March 31.
----------	----------	11,373,500	1,928,752	----------	----------	1912	
----------	----------	11,201,200	1,937,320	----------	----------	1912	
----------	----------	9,602,470	2,110,524	----------	----------	1913	
----------	----------	9,361,980	2,054,224	----------	----------	1913	
1,112,930	47,564	9,010,796	1,706,106	47	82	1913	
----------	----------	8,055,864	1,720,220	----------	----------	1913	
----------	----------	5,927,600	932,008	----------	----------	1912	
----------	----------	5,897,880	1,102,058	----------	----------	1913-14	Do.
[a] 42	2	5,645,256	653,720	----------	----------	1913	
----------	----------	4,241,600	743,988	----------	----------	1912	
----------	----------	3,480,816	705,448	----------	----------	1913	
----------	----------	3,215,516	734,292	----------	----------	1913	
182,227	5,784	2,736,199	519,816	54,778	20,978	1912	
----------	----------	1,524,000	324,000	----------	----------	1914	Crop year.
----------	----------	802,640	210,476	85	68	1913	Includes Cook Islands, etc.
----------	----------	681,736	99,184	----------	----------	1913-14	Year ending June 30.
----------	----------	649,380	111,974	----------	----------	1913	
----------	----------	639,064	139,104	----------	----------	1913	
16,643,332	843,696	524,037	112,464	3,686	2,150	1913	
----------	----------	236,071	31,894	----------	----------	1913	
----------	----------	162,900	29,036	----------	----------	1912	
----------	----------	70,680	11,884	----------	----------	1913	
[a] 958,093	44,046	65,510	11,258	----------	----------	1913	
875,595	30,396	57,252	13,690	----------	----------	1913	
23,769,600	1,318,694	32,049	5,918	313	116	1913	
11,237,000	903,764	----------	----------	----------	----------	1913-14	Year ending June 30. No quantity for value of ₱19,060 exports to foreign countries.
[a] 6,850,411	453,904	----------	----------	----------	----------	1914	
6,352,630	332,938	----------	----------	----------	----------	1913	
4,479,000	287,312	----------	----------	70,768	25,288	1913	
[a] 249,878	16,392	----------	----------	----------	----------	1912-13	Year ending June 30.
864,857	37,482	----------	----------	----------	----------	1913	
[a] 3,648	372	----------	----------	----------	----------	1913	
182,300	19,808	----------	----------	----------	----------	1913	
[a] 743,900	40,348	----------	----------	2,786	1,336	1913	Copra included with coconut exports.
----------	----------	----------	----------	148,916	41,190	1913	
----------	----------	(c)	346,368	----------	----------	1913-14	Year ending March 31.
[a] 340	20	----------	----------	----------	----------	1913	
[a] 180	20	----------	----------	----------	----------	1913	
----------	----------	2,485	336	----------	----------	1913	
[a] 8,750	170	1,320	166	----------	----------	1913	
----------	----------	----------	----------	----------	----------	1913	
----------	----------	----------	----------	757	254	1913	
[a] 7	2	----------	----------	----------	----------	1913	
[a] 252,475	12,936	----------	----------	----------	----------	1913	Excludes nominal quantity of 18,000 nuts exported value ₱438 included.
[a] 10,640	222	4,292	482	----------	----------	1913	
----------	----------	----------	----------	----------	----------	1913	

[b] No quantity. [c] Quantity not available.

The coconut palm has attained its greatest agricultural development in the old world tropics and Oceania, where the nuts are converted to oil or copra; the comparatively light coconut crop produced in the western hemisphere is exported in the form of fresh nuts.

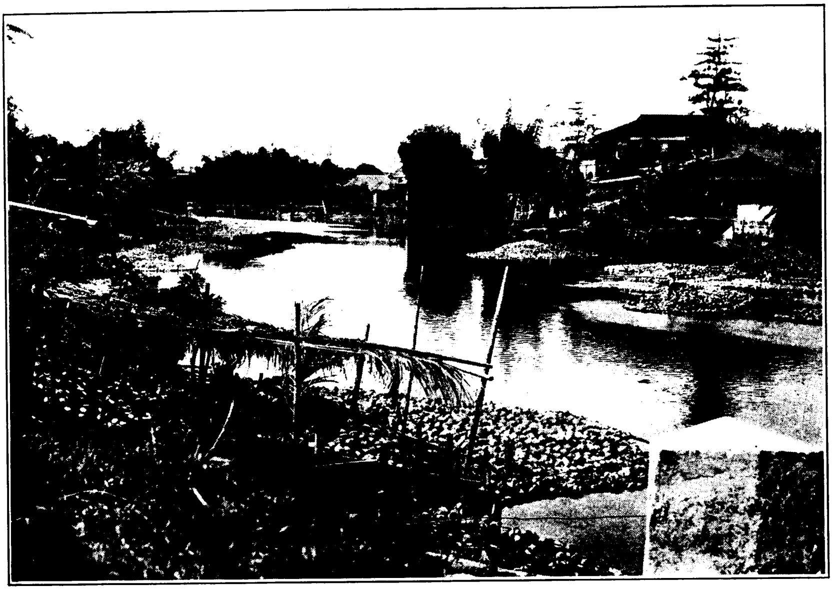
Table IV illustrates the extent of the coconut industry in the various parts of the world and its importance in the trade.

It would thus appear that the Philippines rank as one of the principal copra and coconut oil producing countries in the world. However, some of the other countries have outdistanced the Philippines in the quality of the copra with the result that they command a considerably better price than the Philippine product. Due to the inferior system of handling in harvesting and inferior methods of drying the nuts, with the consequent low prices received for the copra, the annual losses to the Islands must be reckoned at several million pesos. Pratt calculated that the loss to the Philippine copra producer owing to an inferior product as compared with prices for Ceylon copra amounted to more than ₱4,100,000 in 1911.

With the many new uses which have been found for coconut oil, the price of copra in normal times has seen a steady increase and as yet there does not appear to be any basis for the fear that there will be an over-production of coconut oil and copra. The temporary depression in copra prices due to the world war should not worry the far-seeing coconut grower. When peace is declared and industrial conditions readjust themselves, the price of copra and coconut oil is sure to return to its former level, or to even higher prices than before may obtain. So far as the Philippine planter is concerned, it is believed that he could substantially increase his earnings merely by modernizing his methods of culture and of the preparation of the product.

The statement made by the late Mr. W. S. Lyon, fourteen years ago, in "The Coconut," the first publication on the subject under discussion issued by this Bureau, still holds good: "There is no other horticultural tropical product which may be grown in these Islands where crop assurance may be so nearly guaranteed, or natural conditions so nearly controlled by the planter who, knowing the correct principles" (of coconut culture) "has the facilities for applying them."

Considering the increasing demand for coconut products, with a plantation judiciously located and properly cared for, the coconut would appear to be one of the most desirable and profitable crops to occupy the Philippine agriculturist.



(*a*) Coconut rafts on Pagsanjan River, Laguna.

(*b*) Bird's-eye view of the Polo coconut plantation, Dumaguete, Oriental Negros.

Then, again, it is probably no exaggeration to say that the recent construction of three large modern oil mills and many small ones in the Philippines marks a new epoch in the coconut industry of the Islands and places the grower in a more favorable position as to the disposition of his product than heretofore, since he is no longer at the absolute mercy of the foreign buyer of copra, and the successful operation of these concerns is likely to encourage additional investments along this line. A keener competition for coconuts and copra would tend to bring about higher prices for these products, and with local competing mills the better grades of copra would find a readier recognition than they have in the past and should thus encourage the manufacture of a product superior to that heretofore produced. Much as the production of the low-grade article of the past and present may be deplored, it must be recognized that the buyer, considering quantity rather than quality, has done nothing to encourage the grower to raise the quality of his copra and the lack of any stimulus to betterment would naturally tend to cause indifference on the part of the producer.

While even recently set out plantations still leave much to be desired in this respect, it is becoming gradually recognized that close planting is not compatible with good crops of coconuts. Steam and hot-air driers are being introduced, but are as yet not used to any appreciable extent. Broadly speaking, so far the use of these has not had the effect of raising the quality of the product, and most of the copra is still smoke dried.

There are still very large areas of unoccupied land in the Philippines eminently adapted to coconuts, and with an ever increasing demand for copra and oil one may confidently anticipate a rapid expansion of the coconut industry of the Philippines. Coconut products have already taken third place in Philippine exports, and the possibility that they may soon supersede abacá as the chief export crop of the Archipelago is by no means improbable.

The great demand for information about coconuts and their culture emanating from both residents of the Philippines and other countries has long since exhausted the publications on coconuts previously issued by the Bureau, and much of the information relative to the coconut is scattered throughout many periodicals where it is not readily accessible, or it is expressed in technical language not always readily understood by the layman in search of information on the subject. An attempt has therefore been made to digest the data collected during seven years' residence in the Philippines and the available printed in-

formation of the subject and present the essential facts in compact form in popular language.

In order that the latest authentic information on the subject might be included, the various publications on tropical agriculture have been consulted, chief among which may be mentioned "The Coconut," by E. B. Copeland, "Pests and Diseases of the Coconut Palm," by W. W. Froggatt, *The Philippine Agricultural Review, The Philippine Journal of Science, Tropical Agriculturist,* and the Bulletins of the Federated Malay States and the Royal Botanic Gardens, Ceylon. Table IV was courteously prepared by the Bureau of Insular Affairs, War Department, Washington; the other statistics have been furnished by Mr. A. Peña, chief, section of statistics, Bureau of Agriculture.

BOTANY, ORIGIN AND GEOGRAPHICAL DISTRIBUTION.

The coconut, *Cocos nucifera L.*, is a tall, unarmed, monœcious palm, attaining a height of about 25 meters, with a stout, scarred trunk and swelled base, to which are attached 4,000 to 7,000 or more coarse roots, of a remarkably uniform diameter, about 9 centimeters thick, and from 5 to 7 meters long, rarely exceeding 8 meters except in very sandy, poor soil, spreading, seldom descending beyond a depth of 1 meter. The leaves are 4 to sometimes exceeding 6 meters in length, pinnate, and are crowded at the apex of the trunk; the petiole is stout, 1 meter or more long; the leaflets are numerous, up to 1 meter in length, linear-lanceolate, acuminate and leathery. The inflorescence is an axillary panicle up to 1 meter long; the flowers are numerous, small, fragrant and honey-bearing. The fruit is variable in size and shape, 15 to 25 centimeters long, obovoid to subglobose or somewhat flattened, frequently obscurely 3-angled, consisting of a fibrous husk in which is embedded a large seed or "nut," the meat of which lines the inside of the bony endocarp or "shell."

The coconut has been believed by some authorities to be of Asiatic origin, but that its original home was America is now generally conceded. Of prehistoric introduction into Polynesia and tropical Asia, the coconut did not become generally distributed throughout the American tropics until after the discovery of America. The coconut is now well dispersed throughout all parts of the tropics.

COCONUT VARIETIES.

Because of the comparatively recent agricultural importance achieved by the coconut, very little systematic study has been made of the different coconut varieties, and no attempt seems

to have been made to bring together the different forms from the various countries of the tropics except by the French Colonial Government in Madagascar. From the meager and somewhat contradictory statements by different authors, there seems to be a wide field here for original and interesting study of no little practical value.

While it is conceded that there is still much to learn about coconut varieties, the existing literature seems to indicate there are altogether probably not more than 35 distinct coconut varieties, a remarkably small number considering the antiquity of the cultivation and the wide distribution of the coconut. In a plant that must be propagated from seed and is so long-lived, this constancy of characteristics is a distinct advantage; for were the coconut to be even approximately as variable as many of the temperate fruits or the monoembryonic mangos of India, the planting of coconuts would be a vastly more hazardous undertaking than it is now. Climate and soil naturally affect a variety more or less in changing from one set of conditions to another, but in the main a variety may be depended upon to reproduce itself true to type. It is probably true that on comparison many of the Philippine coconut varieties would be found identical with several forms known under different names in other countries.

The following variety names of the coconut in the Philippines have been obtained, chiefly in response to an inquiry sent by this Bureau to the provincial governors throughout the Islands. The provincial dialects are abbreviated as follows:

Bicol, B.; Ibanag, I.; Moro, M.; Pangasinano, P.; Palawano, pa.; Tagalog, T.; Visayo, V.
Adiavan, B.
Agta.
Amamareng, P.
Arufic, I.
Bankalen, pa.
Baongon, M.
Biasongon, V.
Bilangaon, V.
Bucay, V.
Bulao.
Burawis.
Calimbahin, T.
Candong, I.
Caraclan, P.
Capono, V. (A syn. of Macapuno, also spelled Kapono or Capuno.)
Cayomamis, V.
Cuyamis, V. (also spelled with K).
Daakan, P.
Dahili, V. (also spelled Dagile, V.).
Dili, V.
Domano, V.
Domano grande, V.
Domano sawacan, V.
Calimba, P. (Syn. Magalimba).
Ginaring, M.
Guyod, V.
Holandez, V.
Hongoten, M.
Idyukon, M.
Impug, M.
Juñgoton, V. (probably synonym of Hongoten).

Kakalambahin, T.
Kilala, pa. (probably a synonym of Quilala).
Laguna, T.
Layog, V.
Liadmon.
Limba, M. (of which Malimbaon, V., Limbahon, M., Limbaon, V., Lingbaon, V., are probably synonyms).
Lincondana, M.
Lincoranay, V.
Lolombohin, T.
Lonjao, V. (variations of this name are Lonhaw and Lunhao).
Lobog, Pa. (syn. Adiavan B. and Mangipod, T.).
Lono, Pa.
Lopog, Pa.
Lubacan, V.
Lubi, V.
Lupisan, M.
Lusdak, V.
Macapuno, M.
Magalimba, P.
Magsaroro, V.
Malapon, V.
Malaya, V.
Malimbaon, V.
Mamareng, P. (Syn. Amamareng, and Pulipuguen Pa.).
Mamis, M.
Manipod or Mangipod, T.
Niño, M.
Orongoton, Pa. (probably syn. with Hongoten, M.).
Pangosin.
Pikitan, M.
Pilipog, V. (and its variant polipog and Pilipogon V.).
Poti, V., and its variants (Puttan, V., Ampoti, Pa., Putiin, T.).
Pugai, B.
Pulajan, V.
Quilala, V.
Romano, V.
Salumpikit, M.
Tabal, P. (and its variant Taban, P.)
Tagnanam, V.
Tamisan, Pa.
Tapiasin.
Tataguden.
Tutupaen.
Uguis, M. (and its variants Oguis and Oguisan V.).
Virgen, M.
Wandis, V.
Ygod, V.

Unfortunately, lack of time prevented a comparative study of the Philippine coconut varieties before the completion of the manuscript for this publication, but it is planned to discuss this interesting subject in a future issue. Many of the variety names are of course synonymous. There are probably about 12 distinct coconut types in the Archipelago.

The Baongon, Bucay, Daakan, Galimba, Juñgoton, Laguna, Layog, Limba, Lonjao, Lupisan, Malapon, Malaya, Orongoten, Poti, Pulajan, and Romano are considered to be the best for copra in the respective districts where they are grown. Of these the best known are the Romano and Laguna, which can be recommended to planters. The merits of the other varieties should be investigated. In the absence of definite information of this subject, nevertheless it seems quite probable that several of the other copra varieties mentioned are synonymous with the Romano and the Laguna.

Among the other interesting varieties that are found to a

limited extent may be mentioned the Capuno, the meat of which fills the cavity of the shell. Then there is the Tamisan, the husk of which is sweet and edible. The Niño is a dwarf coconut tree that is well adapted for the ornamentation of the garden and the town. Bankalen has a very thick husk and presumably would make a good coir.

In selecting a variety for the production of copra the one with the largest nuts is not necessarily the most desirable, but the one that produces the most copra. A variety bearing small but many nuts may thus be more profitable than one that bears large, but few nuts. A precocious variety is, of course, to be preferred to one that is slow in coming into bearing.

CLIMATE AND SOIL AND LOCATION OF SITE.

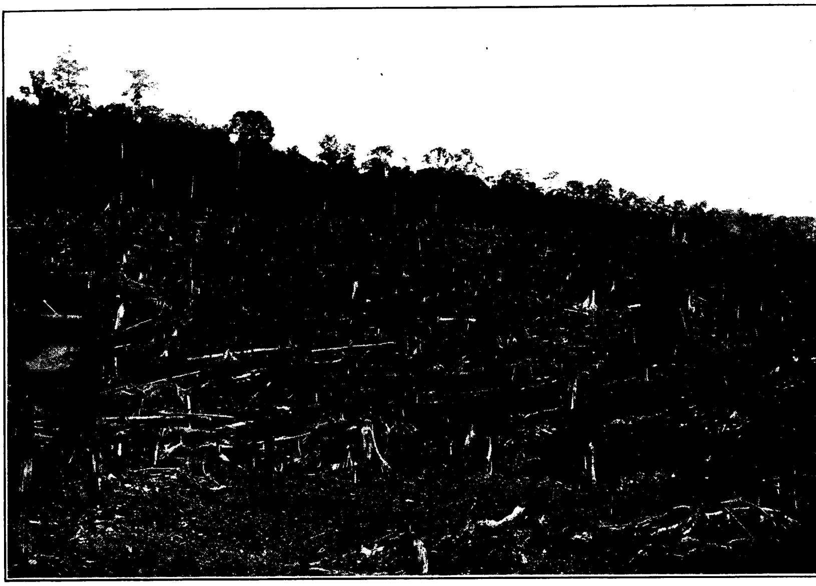
As in other agricultural enterprises, there are several elements that combine to determine success or failure in coconut growing. These are climate, soil, susceptibility to diseases or other agricultural pests, cost of the land, transportation facilities and accessibility to markets, and availability of labor; last but not least comes the manager or superintendent.

Broadly speaking, climate is determined by the latitude, altitude, the proximity to oceans or lakes, rainfall, atmospherical humidity and the air currents, all of which are more or less closely interrelated. Most, perhaps all plants, respond better to one set of climatic conditions than to another, a characteristic referred to as climatic adaptability. The coconut is no exception to this rule.

While for ornamental purposes the coconut may be grown somewhat beyond the torrid zone, in the broad sense the usefulness of this palm as a plantation crop is limited to the tropics. Near the equator the altitudinal range within which the coconut may be profitably cultivated as a plantation crop extends from sea level to an altitude of perhaps 500 meters; beyond this elevation, although the tree may occasionally be grown for home consumption even above 800 meters, the palm cannot be recommended for planting on a large scale. These elevations naturally decrease according to the distance from the equator. Other conditions being equal, the coconut thrives best and is most productive where the precipitation is equal throughout all months of the year, with no prolonged dry periods. If the rainfall is of equal distribution throughout all the months of the year, the coconut may be grown with an annual rainfall of 1,500 millimeters or even less if the ground water ascends within

the reach of the root system. On the other hand it succeeds well where the precipitation exceeds 3,000 millimeters. Zamboanga, Mindanao, where the mean annual precipitation is 926, is sometimes cited as an example of the minimum rainfall with which the coconut will thrive and produce well. This statement, however, is apt to be misconstrued by those who are not familiar with the local conditions. In Zamboanga the land is but a few feet above tidewater and there is an ample supply of ground water within easy reach of the roots of the palm at all times. Then, again, the rainfall is registered at a point where the precipitation is abnormally low and not representative of that in the coconut districts only a few miles away. At the oft-quoted San Ramon Farm the rainfall is certainly not less than 1,500 millimeters and probably more than 1,800 millimeters. For the best results the dry season should perhaps not extend beyond three months, depending to a considerable extent upon the atmospherical humidity and the proximity of ground water. Extreme humidity is said to cause premature decay of the nut, but this is a very rare occurrence and need scarcely be considered in the selection of a site. It is well to remember that the assimilation of plant food and consequently the development and ripening of the nuts is closely related to the amount of sunlight the palms receive. Therefore, other things being equal, that locality with the greatest number of sunny days in the year is the one most favorable for the maximum production of nuts. Whether or not atmospheric stillness or prevalent winds are the most beneficial for the coconut is a mooted question, and may perhaps be considered as of academic interest rather than of very great practical value. At any rate it is not believed to be of sufficient importance to turn the scale in deciding upon a site for a plantation. Storms and typhoons are of course destructive to the season's crop, and where sufficiently severe may do permanent damage to the trees. For the benefit of those who still cling to the belief that the coconut is dependent upon the salt air and breezes of the shore for its best development, it may be briefly stated that there is no sound foundation for such a contention, nor, for that matter, for the belief that salt is beneficial to the tree.

An alluvial, loamy, volcanic or sandy, friable, fertile soil at least 60 centimeters deep, is well adapted to the coconut. Gravel and laterite in moderate amounts are rather beneficial than not. Heavy, compact, water-retaining soils are unsuitable to this palm. It is impatient of stagnant water, but will grow even where the ground water comes close to the surface, provided



(*a*) Coconut land after the burning of the jungle, Isabela, Basilan.

(*b*) Coconuts 3 years 7 months old with patani for cover crop, Isabela, Basilan.

that there is a constant movement of the water in the soil. Occasional inundations, provided that they are not of long duration, do not injure it.

In relation to immunity from coconut pests, the entrance thereof can naturally be better guarded against, or they may be more easily controlled, where the plantation is located on a small island under the absolute jurisdiction, so far as coconuts are concerned, of the owner, than it can on a large island. Therefore, everything else being equal, a small island, somewhat larger than the proposed plantation, or a peninsula, would be the most preferable site for a coconut estate. In the selection of such a site depth of water and the feasibility of the construction of docking facilities should also be considered, especially where the development of a very large estate is contemplated.

In considering the relative merits of the various districts in the Philippines for coconuts it may be said that, within the limits already referred to, the region south of an irregular line drawn from about 8.50° latitude in Lianga bay on the east coast of Mindanao in a west-north-westerly direction north of Camiguin and Siquijor islands, somewhat to the north of Dumaguete, to a point on Palawan about 10.50° latitude, including nearly all of Mindanao, the Sulu Archipelago, Basilan, the southern half of Palawan and adjacent islands and the extreme south of Negros, because of its comparative immunity from typhoons and the equal distribution of the rainfall, is the one most favorable for the coconut in this Archipelago. North of this line, more or less exposed to typhoons but otherwise well adapted to the coconut with reference to the rainfall, are Southern Luzon to Batangas and the eastern slope of Luzon, including Laguna, Catanduanes Island and the Visayas. The western part of Luzon from Batangas and northward has a long, pronounced, dry season and therefore is not so well adapted to the coconut.

If rapidity of growth and vigor are reliable indicators, Mindanao, Basilan and the Sulu Archipelago are certainly preëminently well suited to the coconut, yet the advocates of Southern Negros maintain that notwithstanding a less vigorous development of the palm in this region, the production of nuts is here greater, due to more sunshine and heat and less rainfall. In other words, while in Mindanao and Sulu the conditions are the most favorable for the growth of the coconut palm, Southern Negros possesses more nearly ideal conditions for nut production. While this argument sounds plausible enough, as yet there are no data available to sustain this contention.

THE MANAGER.

Before concluding this chapter it may not be inopportune to mention the importance of the selection of a manager. In any "abaca," whether rubber, coffee, or coconuts, in the rush to "get rich quick," much money has been lost because of the failure to recognize the climatic or other requirements of the crop in question, and because of locating plantations and estates where it was a physical impossibility to make the venture a success. It is also true that there have been many failures where the incompetence of the manager was the principal not to say the sole cause. Prospective investors should realize that it is unreasonable to expect a man from the temperate zone, where climate, agriculture, and crops are so totally different from those in the tropics, to avoid pitfalls and make an immediate success notwithstanding that he has been a success in his former environment; nor may ability to properly administrate a plantation in the tropics be acquired without some years of previous experience as an assistant on a well-managed estate and without a thorough study of the particular crop in question, any more than, for instance, an unexperienced man would be capable of administering a bank or a manufacturing plant. He should be a good executive and understand the handling of labor. The remarkable success of the colonial plantation ventures by the Dutch in Java and Sumatra and by the British in their tropical colonies, are, to no small degree, due to the recognition of these facts.

CLEARING.

If the site of the prospective coconut plantation is occupied by forest, and the location of the site is such that the timber may be disposed of for lumber or wood, this may go a long way toward defraying the expense of the clearing and planting. If this condition does not obtain, the native vegetation had better be cut during the early part of the driest part of the year and burned. Opinions differ as to the advisability of clearing the land of all roots and stumps, including those of the large trees, or of grubbing out the minor roots and stumps and leaving the large stumps to be worn away by the action of fungi and insects. This depends largely upon local conditions, the capital available and the price of labor. Where capital is simple and labor obtainable at a reasonable cost, the clearing out of all but the largest stumps before planting is certainly advisable. However, where the opposite conditions obtain plantations may also be started by the use of the "ring-weeding" method and the planting of *patani* in the middle to choke out the weeds. Then, as

the plants develop, the circles around the trees are gradually widened until eventually the entire middle can be plowed. Where the land is stumped it is usually impractical to remove the large stumps until the roots have decayed so that the stump may be easily removed. This should be done within not less than four years after the coconuts are planted, in order to prevent the stumps from serving as a breeding ground for beetles. This is particularly important in districts where coconut beetles are prevalent.

Grass lands or cogonales should be plowed several times during the dry period until the grass is well under control, after which the land should be planted to a leguminous cover crop simultaneously with the planting of the coconuts. Mr. Henry Fleischer, owner of the Rios and manager of the Polo Coconut plantations, Dumaguete, Negros, who has been eminently successful in the management of these plantations, which contain about 100,000 coconut trees, advocates, wherever possible, the plowing of the land, whatever its original vegetation, to a depth of 3 centimeters, and then allowing it to lie fallow for a year until the coconuts are planted. Local conditions to a large extent determine which of these methods of clearing is to be preferred.

SEED SELECTION AND PROPAGATION.

So far as the writer is aware, no studies have been made of the heredity of the coconut, and it is not known to what degree the various characters of this palm are transmissible. In the meantime it is a safe rule, and in fact it should be the rule, to select for seed nuts those from vigorous, productive trees bearing large nuts that are well developed. Those who wish to carry selection still further should compare the amount of meat and the oil content of the nuts from the individual trees. In fact every coconut planter should keep a performance record of his coconut trees from year to year in order to enable him to extend his plantation with seedlings from his most productive trees. There is no doubt but that such a record would bring to light some very surprising and perhaps unexpected facts. If this record is faithfully kept and the new areas are planted with nuts from the best performers, there is no doubt but that the yield of a plantation would be gradually increased very considerably. If it failed to do so it would be the first time that systematic seed selection had miscarried, an occurrence which is exceedingly improbable.

A simple performance record that could be kept by any one of average intelligence would consist of the numbering of a

series of metal tags made of galvanized sheet iron, and nailing the tags to say 100 to 1,000 or more of the apparently most productive trees according to the need for seed nuts and the size of the plantation.

Such tags might conveniently be made 12 centimeters long and about 7 centimeters wide, and the numbers painted plainly with black or some other color. The tags should be nailed to the trunk of the palms at the same height, about 1.75 meters from the ground, and facing the same direction in order to be readily recognized.

An ordinary ledger may be made to serve as a performance record, as illustrated below:

Coconut performance record.

Year ...., Block, No.......................... Row No. ....
Plantation.. Location...

Tree No.	Date harvested.												Total grade.		Remarks.
	No. nuts grade—		No. nuts grade—		No. nuts grade—		No. nuts grade—		No. nuts grade—		No. nuts grade—				
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
16															

The most productive coconut trees having been ascertained, the seed nuts from these should be lowered to the ground by hand. It should be remembered that these nuts are worth intrinsically much more than the nuts that are made into copra, and that a cracked nut decays and does not germinate; the extra expense in picking these nuts carefully is therefore well justified.

After gathering, the seed nuts should be stacked in a dry, airy place to "cure" for about a month before planting. The nuts are ready to plant in the seed bed when most of the milk has dried up and the meat is hard.

(*a*) One-year-old coconut under clean culture, Patalon, Mindanao.

(*b*) Coconut tree 2 years, 9 months, Balactasan, Basilan.

The seed bed should be plowed repeatedly or spaded, and all roots and trash removed until the land is well worked up to a depth of 30 centimeters. The seed beds may be laid out at any convenient width, say 2 to 2.5 meters, with paths at suitable intervals to allow proper attention to the seeds and weeding.

In planting, the nuts should be spaced so that they are about 7.5 centimeters apart and should be laid on the side, and about one-half to two-thirds of the nut buried in the ground. Then a thin mulch of chopped rice straw, grass or weeds should be placed over the seed beds in order to maintain an even moisture in the soil and prevent the drying out of the nuts. If the mulching has been properly attended to, with one thorough watering of the seed beds after the seed are planted, there should be little or no need for additional irrigation. The erection of a temporary shed of palm leaves or cogon for protection from the sun is advantageous but not essential.

The plants are ready for transplanting to the field when they are 50 to 75 centimeters high and the roots extend 10 to 20 centimeters beyond the husk. In fact the transplanting to the field should not be delayed beyond this stage. (Fig. 1.)

LAYING OUT THE PLANTATION.

SPACING AND STAKING.

The custom in the Philippines of renting or selling coconut plantations at a certain rate per tree instead of according to the area, has been to a large extent responsible for the excessively close-planting practice, 500 trees to the hectare not being uncommon in old plantations. The low yield of nuts per tree, and the many sterile trees are the natural consequence of this close planting, by which the average, not to say the maximum, yield of nuts can never be attained.

All the best authorities on coconuts are agreed that coconuts should not be spaced closer than 8 to 10 meters, depending upon the fertility of the land, and some recommend a distance of 12 meters apart. Ten meters apart is certainly not too great where the soil is rich.

Whatever the distance, the plantation should be laid out in straight rows and the trees set out equidistant in order to facilitate the work in the plantation, to enable the roots to fully utilize the space in the soil, and in order that the tops may equally share the full benefit of the sunlight, for, other conditions being equal, the tree that is most exposed to the light bears the heaviest crops.

As a rule plantations are usually set out according to the square or rectangular system. According to this system the trees are planted so that the rows intersect each other at right angles. If this system is used, the staking operation is most easily performed in the following manner:

Before staking begins, take a wire sufficiently long to stretch across the field in its shortest dimension, and mark off on the wire in bright colored paint the distance at which it is desired to plant the trees, and put aside until the paint has hardened.

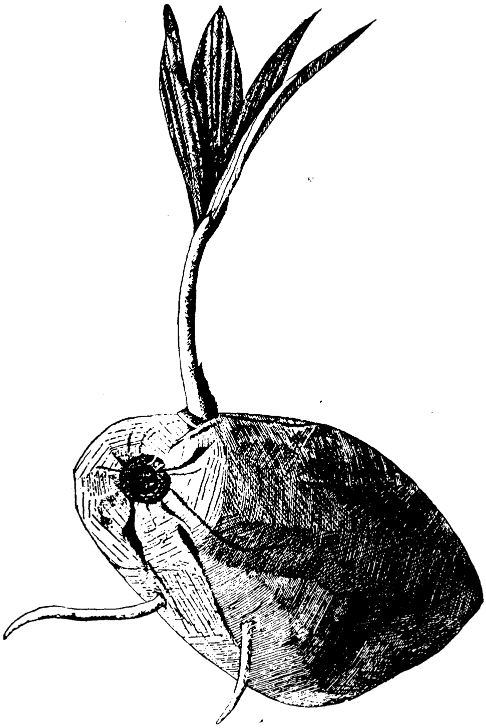


FIG. 1. Germinating coconut. Transplanting from the nursery to the field should not be delayed much beyond this stage of the germination. (After Lyon.)

The easiest way to square off and stake a field is to fasten a carpenter's square on the top of three stakes at one corner of the field, and then with the aid of the square put out two lines of stakes—the stakes being placed at the distances it is desired to plant the trees—so that they intersect at right angles at the point of the square. Then move the square to the last stake in one of the lines and place it so that one of the sides of the square is exactly in the line and that the other side points towards the field. Now sight and stake off another line along this side of the square and again move the square to the last stake in the line last

The coconut tree shown on Plate IV(a) at the age of 5 years and 10 months. The plantation is plowed and disked twice a year.

staked and proceed with the staking as already described. If the work has been carefully performed, the first and the last staked lines should meet each other at right angles, which may be ascertained by placing the square in the fourth corner. The rest of the staking of the field, with the aid of the wire previously prepared, is now a simple matter. Beginning at the first corner, stretch the wire across the field between the first two stakes that are opposite each other, and drive a stake into the ground beside each mark on the wire; when the line is staked move the wire up to the next two stakes opposite each other and proceed until the entire field is staked.

The hexagonal or sextuple system of planting has an advantage over the square system in that by its use approximately 15 per cent more trees can be planted on a given area without additional crowding of the trees than by the use of the square system. The basis of the hexagonal system is the circle instead of the square, six trees being set out equidistant from a seventh placed in the center. The hexagonal is the only system that equally divides the space between the trees. In planting according to this system the staking is facilitated by marking the wire for the stakes alternately with two colors.

By the use of the quincunx system the number of trees per area is increased 78 per cent as compared with the square system, but the trees are crowded accordingly, and, contrary to a commonly accepted belief, this system therefore does not possess any advantage over the other systems of tree planting where thinning of the trees is not contemplated.

Table showing number of trees per hectare planted at given distances according to the square and hexagonal systems.

Distance apart.	Square.	Hexagonal.
Meters.		
8×8	156	179
9×9	123	141
10×10	100	115
11×11	83	95
12×12	70	80

The difference of arrangement of the trees in the two above mentioned systems is illustrated in fig. 2.

WIND BELTS.

In regions subject to heavy winds it may be beneficial to plant wind belts here and there in the plantation. These should consist of strong-growing, vigorous, deep-rooted trees, fruit

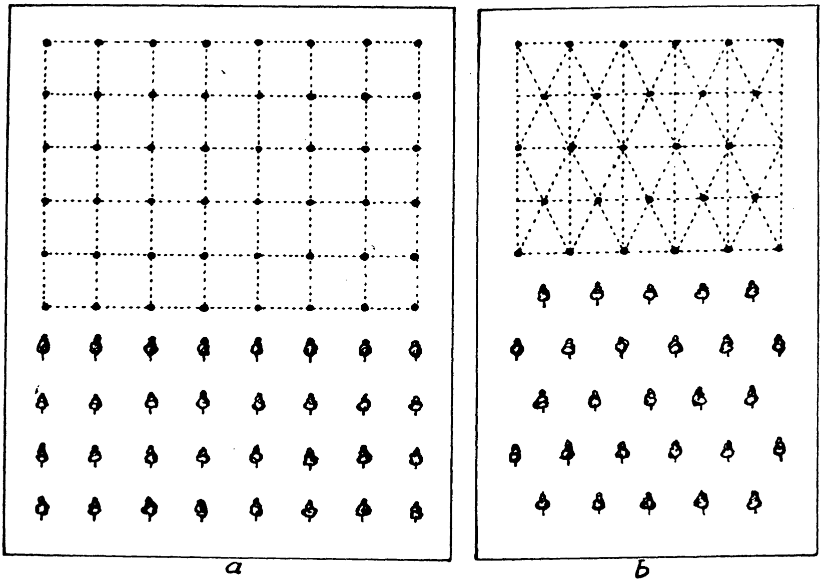


FIG. 2. Diagrams; (*a*) illustrating square and (*b*) hexagonal system of planting.

trees, preferably, well adapted to the region. Among such trees may be mentioned the various species of *Mangifers*, the tamarind, or the mabolo. The bamboo also makes an excellent wind break, but it impoverishes the soil over too great an area around the plants to be entirely suitable for this purpose.

TRANSPORTATION.

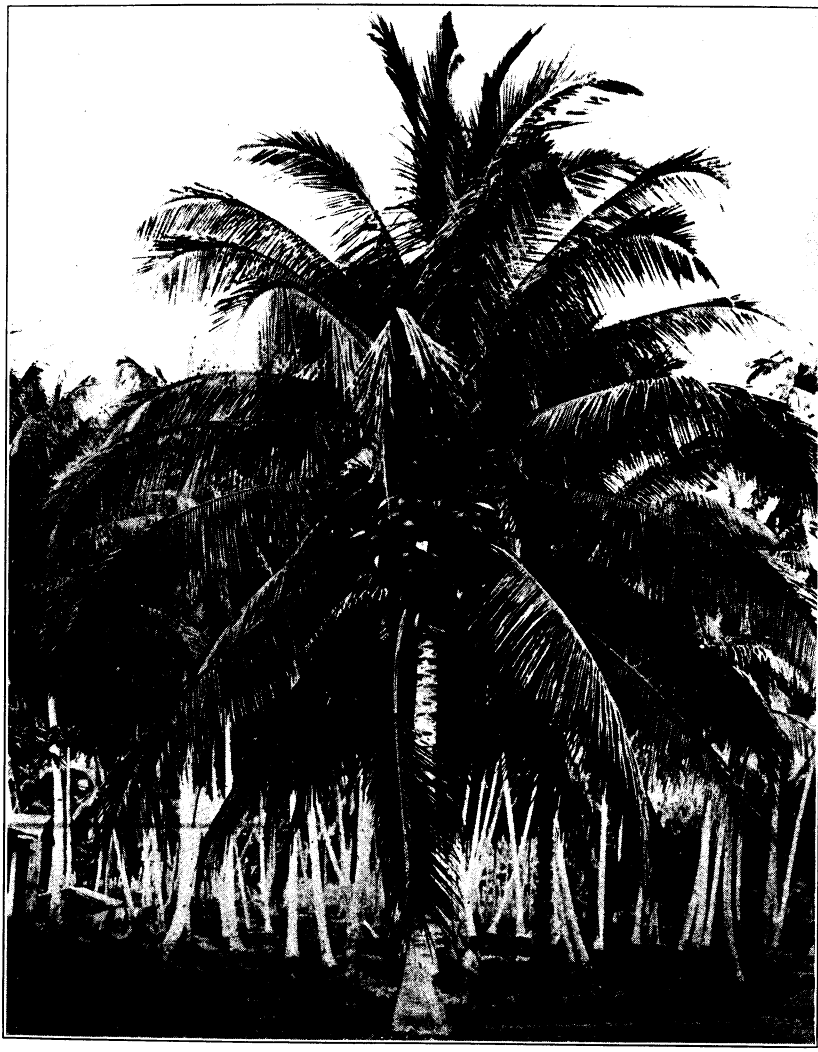
On small holdings the nuts may be transported from the plantation to the drier most conveniently on carabao sleds, but on large estates narrowgauge tramways are possibly the cheapest way of transporting the nuts to the driers.

PLANTING.

It is good practice to dig the holes at least one or two months in advance of the transplanting.

A planting board (fig. 3) will be found of great assistance to those who wish to plant the palms in absolutely straight rows. This board, which may be from 1.5 to 2 meters long, should, after staking and before the digging of the holes, be placed on

FIG. 3. Planting board.



Eight-year-old coconut palm, Zamboanga, Mindanao.

the ground so that the tree stake fits into the central notch, then a small stake is driven into the ground in each notch at the ends of the board, after which everything is ready for digging. The size of the holes depends upon the quality and preparation of the land, the largest holes being necessary on heavy soils or where laterite is abundant. The holes should never be dug less than 50 centimeters in diameter and 50 centimeters deep, and where the ground is not in the best condition a hole 0.75 to 1 meter in diameter is better.

The best practice is unquestionably to transplant the coconut palms from the nursery to the field at the stage of their development indicated on page 22 while the young plants are still firmly attached to the nut and derive the major part of their sustenance therefrom. If transplanted at this stage the nut will be able to assist the plant to recuperate from the shock of transplanting, which at a later stage it cannot do; the cost of transplantation is decreased through the handling of smaller plants, and the danger of loss from the transplanting is smaller when the plants are young than after they have put out several leaves. The transplantation to the field of plants over two years of age is impracticable owing to the expense entailed by the operation.

When the plants are set out in the field as recommended, there is no need to prune the leaves, but if set out after the root system is established in the nursery, it is good practice to remove about one-third of the leaf area of the plants before digging begins in order to reduce evaporation until the plants are well established in their new quarters. The plants should be dug from the nursery with a sharp spade, the young plants should be carefully handled, and care should be taken to avoid bruising and drying of the roots.

The transplanting should be performed sufficiently early during the rainy season to permit the young palms to become well established without the extra expense of watering by hand, and it is well to time the actual work of setting the plants so that it is accompanied by a good rain.

In planting, place the planting board so that the two small stakes fit into the end notches and set the plant so that it fits into the central notch. The holes should be filled with surface soil carefully worked in between the roots and well packed around them and the nut, setting the nut so deep that the upper surface of the mother nut is about even with the ground in the field. The soil that was thrown up in digging the holes should be spread between the trees. If the growing of auxiliary crops is not contemplated, the lands should be planted to a leguminous

cover crop immediately after setting out the coconut plants in the field.

For the smothering of even the most tenacious weeds few if any cover crop equals the native patani, or lima, *Phaseolus lunatus.* Planted about 4 seeds to a hill, in hills 50 centimeters to 1 meter apart and in rows 1 to 2 meters apart, according to the climate and the time of planting, the patani rapidly makes a very effective blanket that smothers the weeds and makes a heavy growth for the enrichment of the ground, which may be plowed under or left for mulch around the trees. After it is once established the patani may be depended upon to make an effective covering for an average of about two years. Then as the plants grow weaker the field should be cleared and again sown to patani.

Passiflora foetida also makes a good cover crop, and sown in the same field competes successfully with the patani, but it of course does not enrich the soil to the same degree.

CULTURE.

If the land is prepared as outlined heretofore it will be in very good condition at the time of planting. From then on until the coconut trees reach bearing age the handling of the plantation will proceed along two entirely different lines according to whether coconuts continue to be the sole crop or whether secondary or catch crops are introduced.

In most plantations coconuts constitute the only crop, others being barred for the reason that the utilization of the land for catch crops requires an extra large labor supply that is not always available.

Where no catch crops are planted there can be no question about the desirability of planting the vacant space to some legume to keep down grasses and other weedy, undesirable vegetation and to enrich the land. For this purpose the patani or lima, *Phaseolus lunatus,* planted as already indicated on page 24 is an excellent cover crop. Two or three cultivations should be given this plant after the sowing of the seed to keep the weeds in check and give the bean vines a fair start. After this the patani is usually capable of taking good care of itself as well as the weeds, including cogon, the worst weed in the Philippines. Thereafter about once every month or so an inspection of the trees should be made and offending vines cleared off the palms. If the growth of the cogon is rank the patani will be greatly assisted in running over the grass if the cogon is broken down by rolling the land with a wooden roller about 500 or more kilos

Typical old style coconut grove. Naujan, Mindoro.

in weight. In exceptional cases it may be necessary to roll the land twice, which then should be done at an interval of 6 weeks to two months. The author has seen this method of controlling heavy growth of cogon used on the Basilan plantations with the most remarkable results, and the superiority of the patani as a cover crop over all other legumes tried up to date in Mindanao, Basilan and the Sulu Archipelago, and in other regions with similar conditions, is beyond question.

Centrosema plumierii is another vine cover crop of great value but a good stand of this plant is difficult to obtain on account of the extreme hardness of the seedcoat, which prevents the prompt germination of the seed. So far as the author is aware, the *Kudzu, Pueraria thumbergiana,* has never been tried as a cover crop but this plant is of such vigorous growth that there is good reason to believe that it would be equally as good as the patani as a cover crop for coconuts. It has the added advantage that it makes a good stock feed. The kudzu is best propagated by cuttings. Various species of *Tephrosia* and *Indigofera* and other upright growing legumes are also suitable as cover crops. Among these *Theprosia candida, T. vogellii* and *Clitoria cajanifolia* are especially recommended. However, climate and various local factors play a great role in the growth of plants. The fact that a legume is highly successful and well recommended in one locality does not predetermine its success in another. Therefore, in introducing new cover crops into a new region it is best to try several before extensive plantings are made. Whatever cover, or "live mulch," as it is sometimes called, is used, in order to obtain a minimum of expense it should be a perennial plant and not an annual, and the vegetation should never be permitted to crowd the coconuts. Upright growing legumes should be pollarded at least three to four times a year and the tops left on the ground to decay, part being placed around the young trees for mulch. If it is desired to improve the ground by the repeated plowing under of green manure crops, cowpeas, lyon, Mauritius or Florida velvet beans or some other quick-growing annual legumes are recommended.

When the plantation comes into bearing the upright growing cover-crop plants would interfere too much with harvesting to allow their continued growth and they should then be cut down close to the ground, and the plantation thereafter be cleaned four times a year or oftener, as the case may require, where no other cultivation is practiced, the leaflets being cut from the petioles and the latter piled and burned.

The above is of course the cheapest way of handling a planta-

tion already in bearing. However, it is a question if plowing of the land twice a year, notwithstanding its greater cost, is not after all the more economical method when production is considered; and though experience is still perhaps too limited to warrant a sweeping assertion in this respect, the indications are in favor of annual cultivation. To what degree clean culture of a coconut plantation would be profitable as compared with a sodded plantation would naturally depend upon local conditions and the cost of labor. In the meantime it has been conclusively demonstrated at the Patalon coconut plantation in Mindanao and the Bios and Polo plantations in Negros that repeated plowing of the plantation after the root system of the palms is fully developed is not injurious but beneficial to the trees. Several blocks of trees just coming into bearing at Patalon that have been plowed and disked twice a year since their third year were recently examined by the author and it is difficult to imagine a stand of coconut trees of a more vigorous, thrifty appearance than those. (Plates IV*a* and V) Mr. Fleischer, of longer and broader experience than any other planter in the Philippines, is also a firm believer in an annual shallow plowing of the bearing plantation. It is true that the plow cuts a considerable number of roots, which to some may be alarming, though when we reflect that the onion-like base of the coconut tree radiates up to more than 7,000 separate roots, it is obvious that the cutting of a few of these cannot materially affect the well being of the tree. Of course the first few plowings and cutting of roots would naturally stimulate the root development in the deeper layers of the soil with a consequent less root injury at a later plowing. The stirring of the soil naturally liberates plant food that under the nonculture system would not be available for the plants.

In the disposal of the leaves the best cultural practice is unquestionably to strip the leaflets from the petiole with a bolo, the small part of the latter being cut to pieces. This together with the leaflets may be left to decay on the ground, the coarser part of the petiole being burned in piles and the ashes scattered. In order to keep the plantation free from débris this should be attended to not less than once to three times a year. However, this is more expensive than the piling and burning of the leaves, and the merits of each system must be decided locally by the manager.

On porous and level land where the rain water percolates through the ground there is obviously no need for this work, but on sloping land and heavier soils where the rain flows away on the surface, short, narrow trenches about 50 centimeters

Unproductive trees; here the result of too close spacing.

deep, dug here and there at right angles to the slope to catch the rainwater, are recommended to prevent erosion and to maintain the fertility of the soil.

AUXILIARY CROPS.

By auxiliary, secondary, or catch crops we understand quick-growing plants that mature early and are interplanted with one of slower growth and habit in order to bring a quicker return from the land.

Catch crops may consist of any annual economic plant, such as rice, corn, cowpeas or cassava; or of perennial plants, such as pineapples, abacá, and coffee. It goes without saying that a part of the coconut plantation should be utilized for catch crops to the extent of growing all the needed rice, corn, vegetables, legumes, and fruit trees adapted to the locality, and all the stock feed necessary. Whether or not auxiliary crops on a large scale should be made a part of the plantation work depends upon the location, market conditions, soil, and supply of labor, and this must necessarily be left for the decision of the manager.

Because of its precocity Robusta coffee has been extensively used as a catch crop for rubber in Java, and it has also been advocated as a catch crop for coconuts. In the latter case it would not be advisable to plant more than two or three rows of coffee between the coconuts, the coffee being planted 2.1 to 2.5 meters apart. The Congo, Canephora, Quillou and Uganda coffees may also be planted as catch crops, but the Liberian, Excelsa, Abeocuta and related coffees, because of the longer time they require to become of bearing age, are unsuitable for catch-crop purposes.

Among fruits that might be successfully interplanted with coconuts are pineapple, banana, papaya, lanzon, and camia and marang, and possibly a few other species that thrive in a semi-shaded position, but the necessary fruit supply for the plantation is most satisfactorily grown in a separate orchard planted for that purpose.

Among annual plants recommended as secondary crops are corn, upland rice, cassava, mongos, cowpeas, and peanuts.

For the culture and handling of the above-mentioned crops the reader is referred to publications devoted to those subjects.

It is well to remember that the preparation of coffee and the manufacture of cassava starch is dependent upon an abundant supply of clean water.

Cattle and hogs should of course never be allowed in a young plantation, but after the trees are beyond the danger of injury

by the animals, cattle raising might well be considered as a by-source of profit if the marketing facilities are good. Hogs are hardly desirable for ranging in a coconut plantation.

It is perhaps scarcely necessary to conclude with the statement that the well-being of the coconut trees should always be the prime consideration in handling a coconut plantation; other crops or the raising of cattle should be subservient to the welfare of the coconut trees. The planting of a subsidiary crop or the cultivation thereof should not be carried so near the coconuts that the trees are injured.

FERTILIZATION.

Soil fertility is not inexhaustible. Some soils are so rich in plant food that the land may be continuously cropped successively for many years without returning anything to the soil, and without apparent diminution of crops, but even the most fertile soil in time becomes depleted of plant food under such a system of cropping.

At present there are such large areas of idle fertile, agricultural land in the Philippines adapted to the coconut that it would be folly to attempt to grow coconuts on land where it would be necessary to apply artificial fertilizer in order to encourage nut production. Such encouragement should be mostly, not to say entirely, a matter of maintaining the inherent fertility of the land and making it available to the palms rather than adding thereto by purchase and application of chemicals.

Plowing and cultivation will assist in liberating all plant foods, and nitrogen can be cheaply added to the soil by means of green manures. So far as is compatible with sound business management depending upon local conditions, such as cost of labor, all the smaller parts of the leaves of the trees should be left to decay, and the larger parts burned and the ashes scattered among the trees. This is likewise true of the husks also and their ashes.

If we consider that the careful planter returns the leaves and the husks and shells or their ashes, according to analyses made by Walker in Mindanao, an annual crop of 7,000 nuts would remove from each hectare in the copra and milk 43.57 kilos of nitrogen, 26.51 kilos of potash, and 13.37 kilos of phosphoric acid. If the husks and shells were not returned to the soil these figures would be 59.42, 60.55, and 16.73 kilos, respectively. The removal of plant food by the leaves need not be considered, taking for granted that these are decayed or burned in the plantation as a matter of course. This is a remarkably light drain upon the fertility of the land considering the value of

The native method of husking coconuts, Laguna.

the crop, particularly contrasted with other crops, such as corn and tobacco. Roughly speaking it will thus be seen that the loss of nitrogen is about three times that of the loss of phosphoric acid, while the loss of potash is twice as heavy where the meat and milk only are removed. In the case of the removal of the entire nut, the loss of nitrogen and potash is about equal, and about five times the loss of phosphoric acid.

While he will do well to keep these figures in mind, the inteligent planter who has selected his land with due care should not need to worry over fertilizer bills for many years. Depletion of soil fertility is soon indicated both by the growth and the appearance of the trees and by the yield; this may then be corrected by the application of artificial manures. Nevertheless, where it is obtainable at a reasonable cost the application of cattle manure, fish refuse, and seaweed will be found beneficial. Cattle manure is largely a nitrogenous fertilizer, fish refuse is chiefly phosphatic, while potash is the chief constituent in seaweeds. Near saw mills, wood ashes may be taken advantage of and should, of course, preferably be unleached. Available guano deposits should not be overlooked.

Before closing it may be stated that scarcely any systematic prolonged experiments with manuring coconuts have been conducted, so far as the author is aware; and definite directions for the applications of artificial fertilizers are correspondingly difficult to give, except in a general way, as is indicated by the analysis quoted.

The growth of the young palms is stimulated by an abundance of nitrogen, which has been provided for if green manure crops are grown. Later, when the trees become of bearing age, phospatic manures and those rich in potash would be the most likely to encourage fruit production.

Any coconut grower who has any considerable area in coconuts would be likely to find it to his advantage to devote a little time and money to experimentation with chemical fertilizer on his bearing trees. Experimental plot units of 25 trees would be a convenient size, and the cost would not be excessive. With careful records kept such work would be of the greatest practical value, considering how little data there is available relative to this subject.

RENOVATION OF OLD PLANTATIONS.

There are few if any coconut plantations more than fifteen years old in the Philippines that have been properly and sufficiently spaced. With the average spacing being reckoned at

200 trees per hectare (and a careful survey would likely indicate a considerably greater number) there are one-fourth to one-half too many trees to almost any given area. The land in the plantations is rarely cultivated except for an occasional catch crop of ginger, in a small way, in Laguna and Tayabas.

Where the trees are set out equidistant and reasonably well spaced, say not less than 6 to 6.5 meters apart, thinning should proceed with caution, since heavy thinning here would leave too much vacant space. On the other hand, judging from the experience at Patalon in Mindanao and the plantations managed by Mr. Fleischer in Dumaguete, Negros, plowing may be safely recommended, though care should be taken not to plow too deep in breaking the first sod, certainly not deeper than 12 centimeters, and it may be well not to plow within one meter of the trees. A subsequent disking would assist in breaking up the turned up sod. This may be followed by a somewhat deeper plowing after 6 months. It goes without saying that available manures that may be had cheaply locally may at the same time be applied to advantage.

In the irregularly spaced groves, which usually are also planted at the rate of over 300 trees to the hectare, a rather heavy thinning can be safely recommended to increase fruit production, particularly if it is accompanied by plowing.

The above recommendations relate to trees less than 45 to 50 years old.

While the renovation of older trees might pay, still it is well to consider it as purely experimental until more light has been shed on this question.

HARVESTING.

In large plantation practice the coconut is ultimately cultivated for the coconut oil, which is made from the copra obtained from the coconut. Therefore it follows that the production of copra with a maximum yield of high-grade oil per hectare, theoretically at least, should be the aim of the grower, even though it must be admitted that while copra is sold solely by weight and appearances and not upon the basis of its oil content there is no material inducement for the grower to adhere to this ideal. Nevertheless, copra with a maximum oil content should be the logical aim of every copra producer, and the coconut growers should strive to make the oil content of the copra instead of weight and appearance the basis of the market price.

The oil content of the copra depends upon the stage of development of the coconut at the time of harvesting. For the pro-

Sun-drying copra on palm-leaf mats.

duction of a high-grade copra it is essential that the nuts remain on the tree until they are fully ripe. Then, again, it should be kept in mind that copra made from immature nuts has a tendency to absorb water from the atmosphere even after it is thoroughly dried, which induces fermentation and molding, with a corresponding loss of oil.

If not picked prematurely the coconuts remain on the trees until thoroughly ripe when they drop from the trees of their own accord, and they are then in such condition that they rarely crack, while in unripe nuts so dropped in the course of picking cracking is a common occurrence. Most authorities are agreed that the best method of harvesting coconuts is to allow the nuts to ripen on the trees and collect the fallen nuts from the ground at regular intervals.

Notwithstanding that in addition to the reasons stated above it is also cheaper to harvest the nuts by allowing them to ripen and fall from the trees as they reach maturity than to pick the nuts from the trees, the latter custom is prevalent in most coconut-growing countries.

In the Philippines the green nuts are gathered from the trees either by the use of knife attached to the end of a bamboo pole by means of which the stems are cut, or notches are cut in stepladder fashion in the trunks of the trees for the pickers to ascend the trees. In order to prevent undue decay such steps as are made should be cut in a slanting fashion so as to shed water; they should never be cut deeper than absolutely necessary. The picking of the nuts may be done at intervals of eight to ten weeks.

Copra made from immature coconut meat has a tendency to reabsorb water after drying; it molds and sours. Therefore, where the green nuts are harvested as in the Philippines, in order to produce a good grade of copra, the nuts should be piled up in a dry place to "cure" for about a month before husking.

The best way to ripen or cure the nuts is to construct curing racks on which to place the nuts. These may be made of bamboo in several tiers, one above another, the "floors" in each tier about 57 centimeters apart and the bottom "floor" about 50 centimeters above the ground to allow free circulation of the air.

On a small plantation a light sled will be found the most convenient vehicle for the transportation of the nuts from the field to the place of husking. On the large estate a narrow-gauge tram-line system, provided with switches and turntables as needed, will be found a labor-saving feature for conveying the nuts from the plantation to the drier.

YIELD.

Owing to close spacing and no cultivation the average annual yield per tree in the Philippines is estimated to 25 nuts, in extreme cases running perhaps not over 10 nuts per coconut tree per year, and then the nuts are small and a large number is required to make a given amount of copra. (Plate VIII.)

In a plantation located with due regard to the requirements of the coconut, and well managed, the yield may be conservatively estimated as follows:

Seventh year, 15 nuts; eighth year, 25 nuts; ninth year, 45 nuts; tenth year, 70 nuts.

After this the last year's crop may be maintained annually for at least 50 to 60 years.

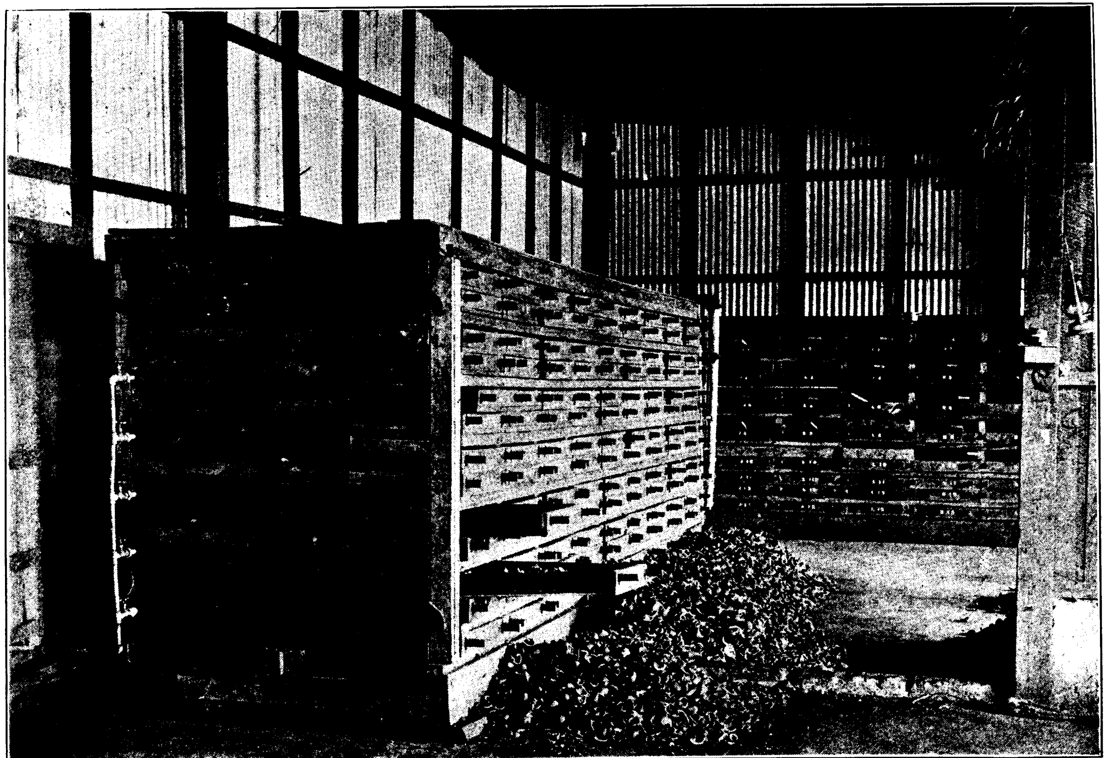
There may be a light crop even the 6th year, but the prospective planter should consider this as a windfall rather than otherwise. On the other hand some planters consider an average estimate of 70 nuts per year per tree on and after the 10th year as below just expectations. If we figure on a distance of 10 meters apart of 100 trees to the hectare this would give an annual crop of 7,000 nuts, while a yield of 60 nuts per tree would give a return of 6,000 nuts per hectare.

In Mindanao, on well cared for estates, 3,270 nuts of the Romano variety are required to make 1 metric ton of copra, while of the smaller nuts produced further north, from 4,000 to 5,600 nuts, of the variety commonly grown in Laguna and Tayabas known under the name "Laguna," are needed to make a ton of copra. In this connection, it may be stated that in Samoa and Trinidad, 6,000 and 6,450 nuts, respectively, are required to make a ton of copra.

COPRA AND COPRA MANUFACTURE.

Copra is the dried meat of the coconut, and at present constitutes the principal and the most important article of export derived from the coconut palm. The meat is dried in the sun or in artificial driers, among which may be classed the so-called "tapahan" driers, in which most of the Philippine copra is prepared.

More recently the Bureau of Science, Manila, has experimented with a method for the preparation of copra by treatment of sulphur dioxide gas, and allowing the meat to dry without addition of artificial heat. (See "Copra and Coconut Oil" by H. C. Bruce, N. O. Harrison, and H. S. Yates, Jour. Sci., 1917.)



The Benito steam copra drier, Magdalena, Laguna.

In order to successfully resist deterioration from molds and bacteria and so produce a first-grade oil and secure the highest price obtainable in the market, copra should be made only of fully matured or "cured" nuts; it should be thoroughly dried so as to make a clean product, containing not more than 6 per cent of water. Ordinary sun-dried copra contains about 9 per cent and "tapahan," or smoke-dried copra, frequently exceeding 20 per cent of moisture, a condition that, particularly in long storage in a moist, damp atmosphere, is all too favorable for the growth of molds, the foremost enemy of improperly prepared and improperly cared for copra, and the formation of fatty acids at the expense of the oil content.

Knowing what constitutes good copra, a glance at the following table is a sufficient exhibit showing the reasons for the inferior price received for Philippine copra. This table is an excerpt from an unpublished manuscript on "Copra and Coconut Oil" by Messrs. H. C. Brill, H. O. Parkes, and H. S. Yates, Bureau of Science, Manila:

TABLE V.—*Moisture content of commercial copra in the Philippines.*

Locality.	Water.	
	Maximum.	Minimum.
	Per cent.	*Per cent.*
San Pablo, Laguna	29.1	18.8
Lucena, Tayabas	23.1	14.5
Atimonan, Tayabas	24.7	15.5
Legazpi, Albay	22.2	17.6
Tacloban, Leyte	20.7	14.4

Where climatic conditions permit, sun drying may be resorted to; in other regions artificial driers must be used.

After the nuts are properly cured they are ready for husking, the first operation in copra making.

Many attempts have been made to invent a mechanical husker, and several power-driven huskers have been devised and placed upon the market. Whatever the reason, such as have been introduced into the Philippines do not seem to have proved satisfactory and none are now in operation, so far as the author is aware. All the husking in the Philippines is done by hand. Considering that an experienced husker can handle 1,000 or more nuts per day, at the present price of labor it seems unlikely that power huskers will supersede manual labor for this process for some time to come.

The husking by hand is a very simple operation and consists

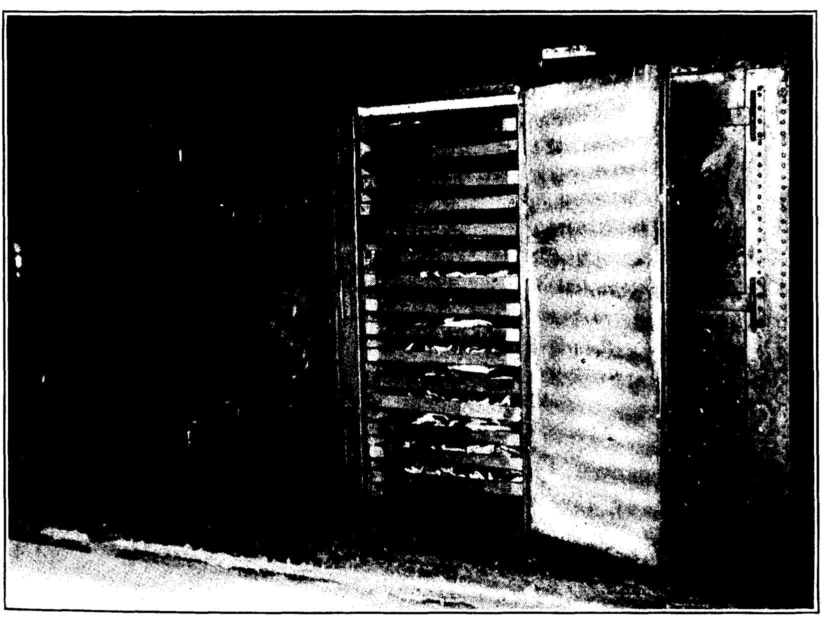
of the use of an ordinary sharp plow-point pointing upward, set into a heavy block of wood, and so high that the point is a little above the knees of the husker. Plate IX illustrates the operation better than could any written description.

After husking, the nuts are cut in halves by a sharp blow with a bolo, which, where the copra is sun dried, are placed face up in the sun to dry for a short time until the meat separates from the shell. After this has been attended to the drying of the meat is completed in the sun and the copra is then ready for the market.

A few artificial copra driers are now being operated, but the amount of copra thus produced is still insignificant and for all practical purposes all the copra in the Philippines is still sun dried or smoke-dried. In the sun drying the halved nuts are first spread on the ground; as the drying proceeds the meat is collected and placed on palm-leaf mats. The smoke or "tapahan" dried copra is produced by placing the meat on bamboo screens over a crude furnace from which the heat and smoke rises and passes through the bamboo screen and meat. A high-grade product suitable for the manufacture of edible products can not be made with the "tapahan" drier, which cannot be too strongly condemned, and as a matter of fact the abolition of this system of drying is only a question of time, when the difference in price between clean, sun dried or machine-dried and smoke-dried copra will be so great as to automatically force the "tapahan" drier out of business.

In the rainy coconut districts artificial driers will of course be imperative, but in those regions where the bright days are sufficient to render the perfect drying of the meat practicable, for instance in Cebu and Bohol, sun-drying is particularly well adapted to the needs of the small, individual producer, for sunlight and heat may be had without the asking. However, in order to produce a better and cleaner copra, the present custom of spreading the coconut meat upon the ground should be distinued. Trays should be made of bamboo, upon which to place the meat for exposure in the sun the same as is done in drying fish. Not only would copra prepared in this way command a premium because of its cleanliness, but the handling of the meat itself from the time of placing it in the sun until sacked would be facilitated; in the case of threatening rain it would easily and rapidly be placed under shelter. Such trays might be made of any convenient size for two men to carry, one at each end of the tray. Since bamboo grows everywhere the cost of making

(*a*) A unit of the McCord hot-air copra drier.



(*b*) A unit of the McCord hot-air copra drier, showing the arrangement of trays in the drying chamber.

these trays would not be great. With reasonable care they would last a long time, and they could be made by the producer himself at a very low initial cost. A tray 2 by 1 meter is suggested as a suitable and convenient size. As these trays, filled with coconut meat, are placed in the sun for drying they should not be spread upon the ground, but raised therefrom by the means of scantlings or bamboo upon which they are placed; this would insure clean copra, and by the better circulation of air hasten the drying. The drying ground should of course have a shed where the trays may be stacked in case of a sudden rain and for the storage of the dried copra. The producer will do well to always keep in mind that dry, clean copra is equivalent to top prices. The floor of the copra bins should therefore always be well raised above the ground to prevent access of water, which induces the formation of molds. The copra should never be stored on the ground. An open, ventilated bamboo floor, not less than 50 centimeters above the ground, would serve the purpose well.

The above paragraphs refer more particularly to the small producer in those districts where sun-drying is feasible. In the largest coconut-growing areas, however, the planter must reckon on the installation of an artificial drier if, as he should, he desires to produce a high-grade copra. The statements that will presently be given relative to cost of installation, operation, and capacity will enable the large grower to decide as to what drier would be best adapted to his special needs.

In the case of the small planter the obvious course to pursue would be either to sell his nuts or to organize a coöperative drying enterprise.

Before breaking ground for a coöperative drying plant, a careful estimate should be made for the prospective tributary area in order to avoid waste and the installation of disproportionate machinery. The importance of this preliminary work cannot be overestimated, since the more nicely the available supply of nuts is adjusted to the full capacity of the drying plant the lower will be the operating expenses. Distance and transportation costs should be carefully considered.

Modern copra driers may be divided into two types, those where the meat is dried by means of superheated steam, and those where the meat is dried by hot air. Both types are such recent inventions that we may expect considerable modifications in the models now in use until more perfect driers shall have been perfected.

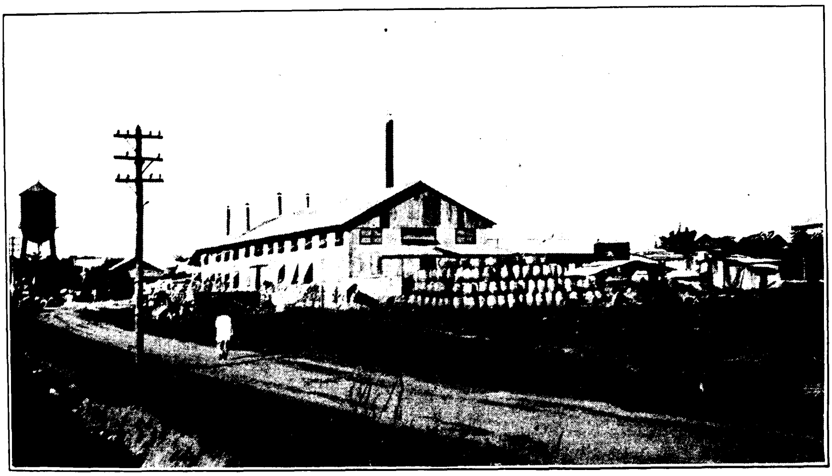
Coconut growers that contemplate the installation of copra driers will find the discussion of driers in "Coconuts, the Consuls of the East, by H. Hamel Smith and F. A. G. Pape, of interest.

Probably the first steam-heated drier was designed by Mr. O. W. Barrett, in 1911, then chief of the division of horticulture of this Bureau. This drier, which was exhibited by the Bureau of Agriculutre in 1912 at the first Philippine Exposition, was constructed of sheet iron with asbestos lining between the iron sheets. The steam entered the drier from the boiler in a section of pipes laid in the bottom, above which were trays on which the halved nuts were placed.

The tests made by this drier were quite satisfactory, considering that it was the first model constructed, and was put into operation without any preliminary test. The model was a small one only but it was estimated that "a drier constructed along similar lines with reinforced concrete walls, boiler and accessories complete, having a capacity of 15,000 nuts per 24 hours, can be constructed for approximately ₱2,500." This drier turned out dry copra in 15 hours.

A modification of this drier was later constructed by Pedro Benito in Magdalena, Laguna, in which the steam pipes instead of all being placed at the bottom were installed at different heights between the trays, an obvious improvement in that it insured more equal distribution of the heat (Pl. XI). At the San Ramon Farm, Zamboanga, Mindanao, a steam drier has also been installed where the meat is placed in large trays above a system of pipes. All these driers produce copra of good quality, but much remains to be done before the apparatus is perfected so as to render better service commensurate with costs of construction and operation.

One of the most efficient and compact hot-air driers in use in the Philippines to date is probably the McCord drier. This drier, which has been patented and is now manufactured by a company in Manila, is made in units containing eight drying chambers or in double units of 16 chambers, with four doors on opposite sides. (Pl. XII). Each chamber is 1.13 meters high, 51 centimeters wide and 59 centimeters deep, and contains 15 shallow trays of perforated sheet iron or wire netting which are slid into the chamber on narrow sheet iron flanges. The walls are made of sheet iron with space under and between the drying chambers for the passage of the hot air, this space between the drying chambers being 75 millimeters. The inside walls of the drying chambers are provided with openings for the ingress of the hot air from the bottom and the sides. The



Copra Central, San Pablo, Laguna.

moisture laden air is discharged through a large circular vent at the top. In operating the drier, air is forced by the means of a blower into a chamber above the furnace made in concrete on the level of the floor to be heated; from there the hot air is then forced through the aforementioned air passages and into the drying chambers containing the coconut meat, whence the moist air, as stated, passes out at the top. According to Mr. McCord, copra containing not more than 5 to 6 per cent of moisture is turned out of this drier after four hours of drying, the capacity of a double unit at one time being 365 kilos of copra. Under prewar conditions the cost of construction of a double unit was ₱2,500 exclusive of concrete work, power machinery and blower. The McCord drier is well worthy of investigation by any one in the Philippines contemplating the installation of a copra drier.

Another copra drier that appears promising has been invented by Mr. J. L. Pierce, Manila, which will shortly be placed on the market. This is also a hot-air drier. The meat is fed into the drier on an endless wide belt on which it is carried through the machine at a slow speed.

The dry copra is passed out of the machine after four hours of drying.

A McCord drier including three units or 48 drying chambers is now successfully in operation in San Pablo, Laguna. This drier has a blower that forces 13,000 cubic feet of air per minute through the drying chambers and requires an engine of 12 horsepower.

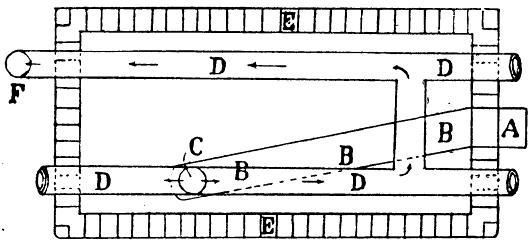
The drying outfit includes a steam boiler for the generation of steam, and a wooden steam vat in which the nuts are steamed preparatory to drying, divided into six compartments. Each compartment is 2.10 meters long, 1.30 meters wide, and 1.25 meters deep, with a capacity of 2,000 nuts. The top is hinged so that it can be entirely opened to receive the nuts. The floor is inclined to one side of the compartment which is hinged downward, so that when the steaming of the nuts has been completed and the door opened the nuts automatically roll out upon a platform where they are halved.

The copra manufacture here proceeds as follows:

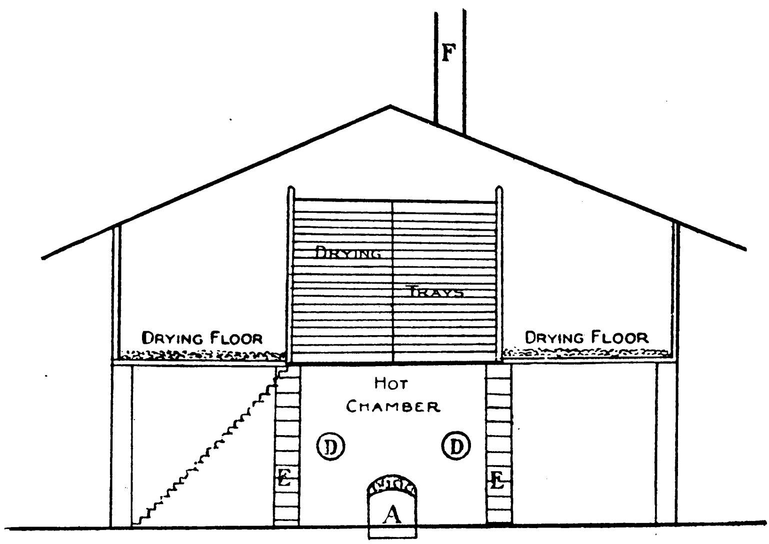
After being husked, the nuts are thrown into the box and steamed about 10 to 15 minutes. The nuts are then halved, and the meat separated from the shell, which is easily done because of the steaming. The meat is then placed on the trays in the drier and after a period of 4 hours, which is sufficient to expel the water in the meat, is taken out of the drier, and the dried

copra conveyed to the cutting machine through which it passes before being bagged ready for the market.

Dr. E. B. Copeland, formerly Dean of the College of Agriculture, Los Baños, quotes in "The Coconut" the following description of a type of copra-drying house used by the Deutsche



GROUND PLAN.



SECTION.

FIG. 4. Copra drying house in Samoa. Ground plan and cross section. A, furnace; B, masonry flue; C, connection of masonry and iron flues; D, iron flue; E, stone wall; F, chimney.

Handel- und Plantagen-Gesellschaft in Samoa, which description was first published by Preuss in 1907:

The house (fig. 4) the outer walls of which are supported by wooden posts set in cement, is set over a smaller room of masonry, in which the air is heated. This hot room is, in one of the driers described as typical, 5 meters long, 2.3 meters wide and 2.3 meters high. Set into the wall of

Native coconut-oil press, Laguna.

the middle of one end is the fireplace. A flue of stone runs from the fireplace obliquely, well toward the outer end of the room. It is there connected by a vertical piece of tubing with a horizontal system of sheet-iron flues, consisting of two or three lengthwise sections (two in the figure) and the necessary crosswise connections. The iron flues are 30 centimeters in diameter, made locally from sheets. The ends project beyond the walls, and can be opened when the pipes need cleaning. The last flue ends in a chimney 12 meters high. The course of the smoke is indicated by arrows.

The drying room proper is directly over the heating room and very little larger, and the floor between them is merely a grating. In operation the drying room is filled with trays of copra, each holding about three kilos. Different driers have capacity of 200 to 394 trays. The local custom is said to be to remove the copra from the shell without any preliminary drying, which is laborious and inevitably involves breaking it into small pieces. Assuming a yield of 2 tons a year per hectare, a drier then will take care of the yield of 150 hectares. How large an area can well be made tributary to one drier depends of course on the means and cost of transporting the nuts as well as on other local conditions.

In German New Guinea and the Bismarck Archipelago a drier is built for each hectare. Preuss states that one of them will dry 1,700 pounds of copra in 24 hours or 300 tons a year. The temperature is kept near 50° C. When the copra is taken from the drying chamber it is spread over the floor of the building to cool and to dry a little more perfectly. Unless the drying is finished in this way the copra is said to mold; but with proper treatment the product is of excellent quality. One of these drying houses costs ₱3,000 to ₱3,500.

MISCELLANEOUS COCONUT PRODUCTS.

COCONUT OIL.

With the erection of two modern coconut-oil mills in the Philippines and an export of 13,598,432 kilos of oil valued at ₱5,976,322 many readers may object to having oil called a "miscellaneous" coconut product; but oil is here considered as made and used locally and not as an industrial product in a large sense.

Various local methods are used for the extraction of oil, nearly always from the fresh nuts, from which the meat is removed with the aid of steel burrs operated by a treadle.

The meat is then heated and the oil expressed. All methods employed are crued and much of the oil is lost. (Plate XIV).

In modern mills 65 to over 70 per cent of the oil can be extracted according to the grade of copra.

COPRA MEAL.

This is a by-product of the modern oil mill, rather than of the coconut palm, which has made its appearance in the Philippines

since the establishment of the coconut-oil mills. Where the oil is hydraulically extracted and the copra is sun or machine-dried the copra meal makes an excellent feed for domestic animals and an excellent fertilizer.

COIR.

Coir is the fiber obtained from the husk of the coconut that is used for various purposes wherever the coconut is cultivated to any appreciable extent. As an article for export coir is manufactured principally in Ceylon, India, the Laccadives, and the Federated Malay States. Coir was formerly of slight importance; but with the invention of coir manufacturing machinery, coir has found useful employment in many ways. It is now used in making cordage, rugs, mats, brushes, upholstery, brooms, mattresses, for caulking, and various other purposes.

The best grade of coir is obtained from the nuts before they are ripe, but the revenue from copra is so great as compared with that from the best coir that the production of coir at the expense of the copra is unprofitable; hence coir will only be a by-product so to speak, of copra, and at present it is not even that in the Philippines, practically all husks, except a few that may be used locally, being allowed to go to waste or used as fuel. So far as known, coir machinery has never been introduced in the Philippines, though it seems reasonable that if the conversation? of husks to coir is profitable in other coconut-growing countries, it would be so here if properly handled. As the leading copra-producing country in the world it would seem logical that the Philippines should also take a lead in coir production and export.

Most of the coir is produced by first retting the husks in salt water and then beating them with mallets but within recent years fiber-extracting machinery has been invented that is said to be quite satisfactory.

According to the estimate made by Mr. M. M. Saleeby, formerly chief of the fiber division of this Bureau, the coconut husks from one hectare of coconuts at the yield stated on a previous page would produce per year 490 kilos of yarn and 70 kilos of brush fiber.

Among other possible by-products are buttons from the coconut shells.

It has been found that the fermented milk can be utilized in the coagulation of latex in place of acetic acid in the preparation of rubber. The burned shells might be utilized as bone char in sugar manufacture.

Coconut trees with bamboo bridges for gathering palm wine, Laguna.

PALM WINE AND ARRACK.

Palm wine and arrack is obtained by cutting the immature inflorescence of the coconut and collecting, fermenting, and distilling the exuding sap that otherwise would have served for the development of the flowers and to form the nuts. The production of palm wine and arrack is of considerable local importance in most countries where the coconut is at all extensively cultivated. As may be seen from the statistics on a preceding page palm-wine manufacture has assumed considerable proportions in the Philippines.

From experiments made by Gibbs in this Archipelago, a tree will produce from 0.35 to over 1.40 liters of sap per day. From one to three flowerspikes are tapped at a time, the sap flow from an inflorescence, continuing usually from 25 to about 40 days. The sap is gathered two or three times daily by the collectors, who at the same time make a fresh cut off the inflorescence in order to increase the flow of sap. Bamboos are tied between the palms to serve as bridges for the sap gatherers. (Plate XV.)

VINEGAR.

Excellent vinegar is also made from the fermented palm sap, but the utilization of the sap for this purpose is of slight importance.

SUGAR.

Sugar may be obtained from the unfermented palm sap. This also is purely local industry which is of no importance in the world's trade and needs only passing mention.

DESICCATED COCONUTS.

Practically all the nuts produced and exported in the American tropics are consumed in the manufacture of dessicated or dried, coconut meat which is put up and used in various ways for culinary purposes.

MINOR USES OF THE FRESH NUT.

Being extensively used as food and drink by the native inhabitants in all countries where it is grown, the coconut is not so appreciated by the Caucasian resident in the tropics as it deserves to be considering its nutritive and gustatory qualities.

No one needs an introduction to the fresh milk or the jelly-like meat in the immature coconut, but the following hints may be found useful.

Coconut cream may be prepared by grating the fresh meat, which is strained with a little water through a cheese cloth. This cream may be used in various ways in preparing puddings, cakes

etc., the same as dairy cream and it imparts a delicious flavor to the dish.

Delicious ice cream and sherbet may be made from the grated nut. The nut may also be used as a filling for pie. Properly made coconut candy is unexcelled.

NATIVE USES OF THE COCONUT.

The major uses of the coconut tree and its fruit have been discussed at more or less length, but in addition it has found employment in various other ways. Few plants, if indeed any, are so serviceable in so many ways to primitive man as the coconut. The roots furnish a dye; the trunks are used for building material; the leaves are employed for thatching; the midrib serves in making baskets, brooms and brushes; the husk may be used as a scouring brush and together with the shell as fuel; the shell is also made into cups, ladles, spoons and other utensils. Numerous other uses of the coconut palm might be enumerated.

COCONUT PESTS.

GENERAL STATEMENT.

Perhaps there is no better evidence of the recent entrance of the coconut into the group of important agricultural crop plants than the fact that even in publications not a score of years old the coconut is spoken of as being one of those few plants that seemed to be nearly if not quite immune to plant pests. However the coconut has only served to emphasize the fact that scattered plants, due to their isolation and the difficulty of transmigration of pests from plant to plant and also because of lack of subsistence, make immunity of a species apparent rather than real. As large areas are planted to a species its inherent enemies find more favorable opportunity for development and multiplication, and a fungus, bacterium or an insect pest that, figuratively speaking, had existed since the beginning of time, merely remained unnoticed until its host became of sufficient industrial importance to necessitate its extensive cultivation. The coconut, in common with all other cultivated crops, has its quota of fungous, bacterial, and insect pests, some of which, if no measures were taken for their control, would rapidly wipe out coconut growing as an agricultural enterprise or reduce the profits to a minimum.

The perpetuity of summer with no marked seasonal changes to interrupt the development of plant pests, renders these vastly more dangerous in the tropics than in the temperate zone, a

(*a*) Coconut tree infested with budrot.

(*b*) Coconuts after an attack of locusts.

matter that might profitably be pondered, both by the planters and the Government institutions charged with looking out for the welfare of the agricultural industries of a country. There should be a stringent plant quarantine as protective measure against the invasion of foreign plant pests, and the law-making bodies should make adequate provisions for compulsory sanitary measure interiorally. It may be positively stated that with or without such laws, if in the former instance not enforced, considering the serious nature of some of the coconut pests, coconut growing will never attain and maintain itself as a truly great industry anywhere. This is peculiarly true of the Philippine Islands, where the three greatest coconut evils have already made their appearance—the budrot, the uang, and the dalipos. The people should be educated to understand the dangerous nature of the coconut pests and to the need of their control and eradication.

The coconut pests may conveniently be segregated into: (1) Fungi and bacteria, (2) insect enemies, and (3) miscellaneous pests.

The existing literature on coconut pests is rather fragmentary, and scattered in many pamphlets and papers published in various periodicals. The most comprehensive discussions on the subject that have come to the attention of the author are "Pests and Diseases of the Coconut Palm," by W. W. Froggatt, a bulletin issued by the Department of New South Wales, and "The Coconut," by E. B. Copeland, both published in 1914.

FUNGI AND BACTERIA.

Fungi and bacteria are so similar in their practical aspect in relation to coconut growing that they are placed in the same group. In fact the disease known as budrot is caused by either of these organisms.

Budrot (Plate XVI*a*). This is by far the most serious enemy of the coconuts, in fact, as a menace to the coconut industry it is comparable with the *uang* and the *dalipos,* the two insect pests that will be described presently. Butler states that in India the budrot is caused by a fungus, *Pythium palmivorum,* while Johnston has shown that in the West Indies the same disease is produced by a bacterium, *Bacillus coli.* In the Philippines Prof. Otto A. Reinking, College of Agriculture, University of the Philippines, has recently demonstrated that the budrot here is of bacterial origin.

Budrot has caused enormous losses in Cuba and has also caused serious losses in Jamaica, Trinidad, and in the Madras Presi-

dency, India; it has been reported from Ceylon, Portuguese East Africa, and other coconut-growing countries. In the Philippines budrot has appeared in Laguna, Tayabas, and Pangasinan, but prompt measures have arrested the spread of the disease so that the situation is well under control at present. The budrot in the Philippines was first reported in 1907. The following description of the disease in the Philippines is quoted verbatim from "The Coconut" by Copeland:

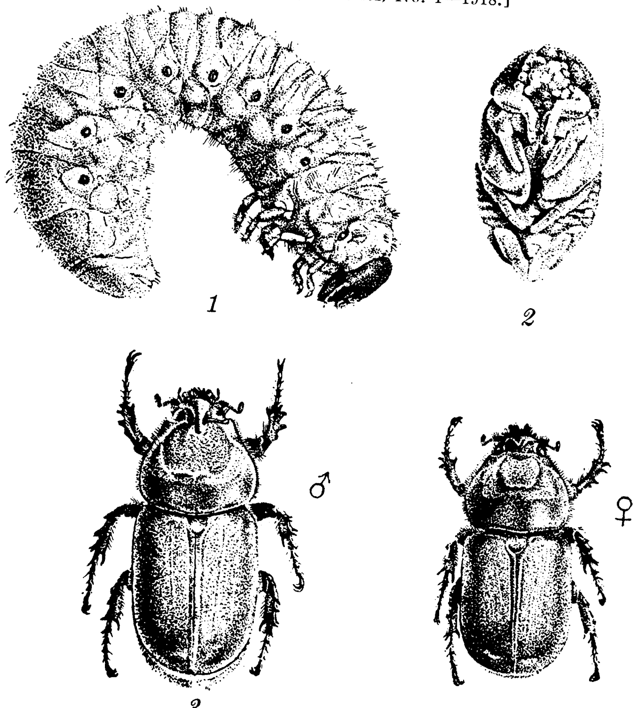
> The first symptom, always in young trees, and always in old ones, is the yellowing and wilting of the youngest, still folded leaf. The disease attacks the soft, undifferentiated tissue of growing points. It is likely that infection normally occurs where the germs can get direct access to these points without penetrating through mature tissue; but the germs might also be borne by insects which could carry them in through mechanical lesions in old tissue. In young trees the youngest leaf presents the only possible path of direct unaided infection; and, however infection may occur the youngest leaf is directly inserted in the tissue susceptible to rot, and must die before the rot embraces the most of the soft tissue commonly called the cabbage. As soon as the youngest leaf is noticeably discolored it can easily be drawn out. The next youngest leaves follow in rapid succession. Within from two to four months after the disease can first be detected the most of the leaves will have fallen. A few of the oldest leaves grow from tissue so hard that the rot makes little or no progress in sit; these leaves, four to a dozen in number, persist for months after the younger leaves are gone. It is in this stage, with a thin whorl of old leaves crowning the stem, that the most of the deseased trees are found. These leaves very likely fall only when their natural time comes uninfluenced by the rot. As is true of budrot everywhere the decaying tissue has a vile and powerful odor.

Remedy.—Because of the nature of the disease infected trees are incurable. All that can be done is to prevent infection of other trees. For this reason trees infected with budrot should be cut down and all parts of the tree likely to carry infection should be burned. Great care should be taken not to spread the disease by the tools used in the course of fighting the budrot from infected to healthy trees. The implements should be dipped in a strong carbolic-acid solution after the completion of the work.

Pestolozzia palmarum is a leaf disease of the coconut that has been reported as doing much damage in Java. It has also appeared in the Philippines, though nowhere has it caused serious injury so far as known. It is also reported from several other coconut-growing countries and is probably of general distribution throughout the Tropics. The disease is characterized by the leaflets toward the apex of the leaves assuming a wilted appearance, and then dying and turning grey.

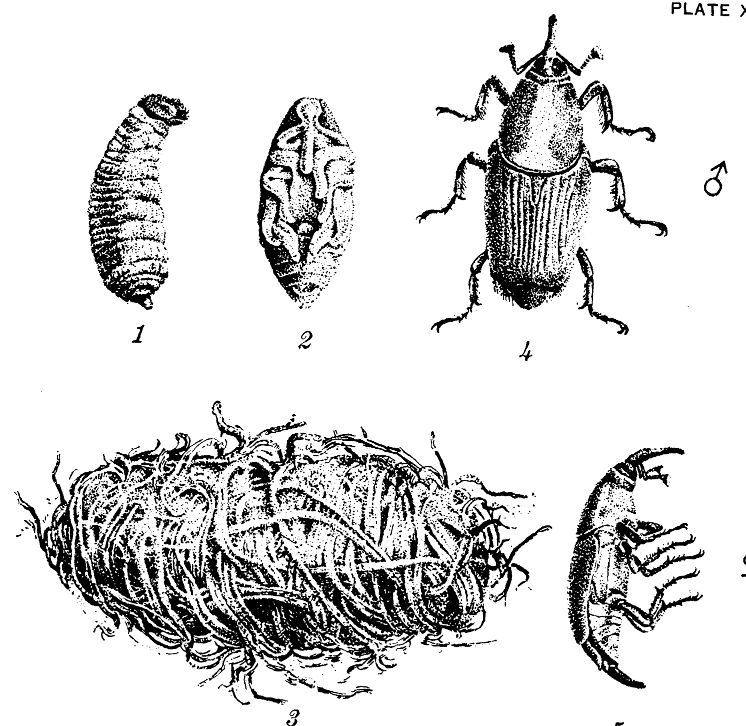
Remedy.—Cut and burn the leaves most seriously affected and

PLATE XVII.



(*a*).—*Oryctes Rhynoceros* L.

FIG. 1. Larva.
2. Pupa.
FIG. 3. Adult male.
4. Adult female.



(*b*).—*Rhynchophorus Ferrugineus* Oliv.

FIG. 1. Larva.
2. Pupa.
3. Cocoon.
FIG. 4. Adult male.
5. Adult female, showing ovipositor.

then spray with Bordeaux mixture (formula No. 1). If necessary repeat the spraying in the course of 15 to 20 days.

The stem-bleeding disease is in India caused by the fungus *Thielaviopsis ethecetica* and in the West Indies by *T. paradoxa.* The disease is thus characterized by Petch:

> A brown liquid oozes out through the cracks in the cortex, and forms a rusty patch which usually turns black afterwards. On cutting into this patch, the internal tissues are found to be discolored and decaying; they are brownish and finally turn black. If the diseased area is cut in wet weather the liquid sometimes squirts out; in fact, it may in some stages be collected in a glass by simply pressing on the diseased patch. After some time other black patches appear on the trunk, usually on the same side. When this happens it will generally be found that this is not a new infection, but that the disease has worked up or down the stem, and the liquid has found a new outlet. I have seen trees which looked as if a bucket of tar had been poured down one side of the stem. It is important to note that there is no sign of the disease until the liquid oozes out, and that when this occurs the internal tissue is already decayed to some extent.

The coconut stem-bleeding disease so far has not appeared in the Philippines.

Remedy.—Petch recommends that "At the first appearance of the disease the affected part should be cut out, the wound burnt with a torch and then covered with hot coal tar. The pieces cut out must be burned. When the disease has advanced so far that this local treatment is impossible the tree must be cut down and burned.

Diplodia spp. and *Botryodiplodia* spp. are considered to be the cause of great damage to the coconut palm in Trinidad, Guiana, and India. This is a root disease that spreads both through the air and in the soil. The trees assume the appearance of suffering from drought and finally die. This rather obscure disease which also is believed to attack the leaves has not been reported from the Philippines.

Remedies.—The following measures are recommended: Destroy the infection by fire or applications of unslaked lime on the exposed soil; isolate the infected area by trenching; cut off the infested leaves and spray with formula No. 1. (Page 55.)

Fomes semitostus is parasitic on the coconut but is generally considered to be of minor importance. The palm is the host of several other fungi which so far are not regarded as serious pests.

INSECT ENEMIES.

The insect pests of the coconut are numerous, and the life history of even several of the most important is but imperfectly

known. As the culture of the palm expands many new ones will undoubtedly be recorded.

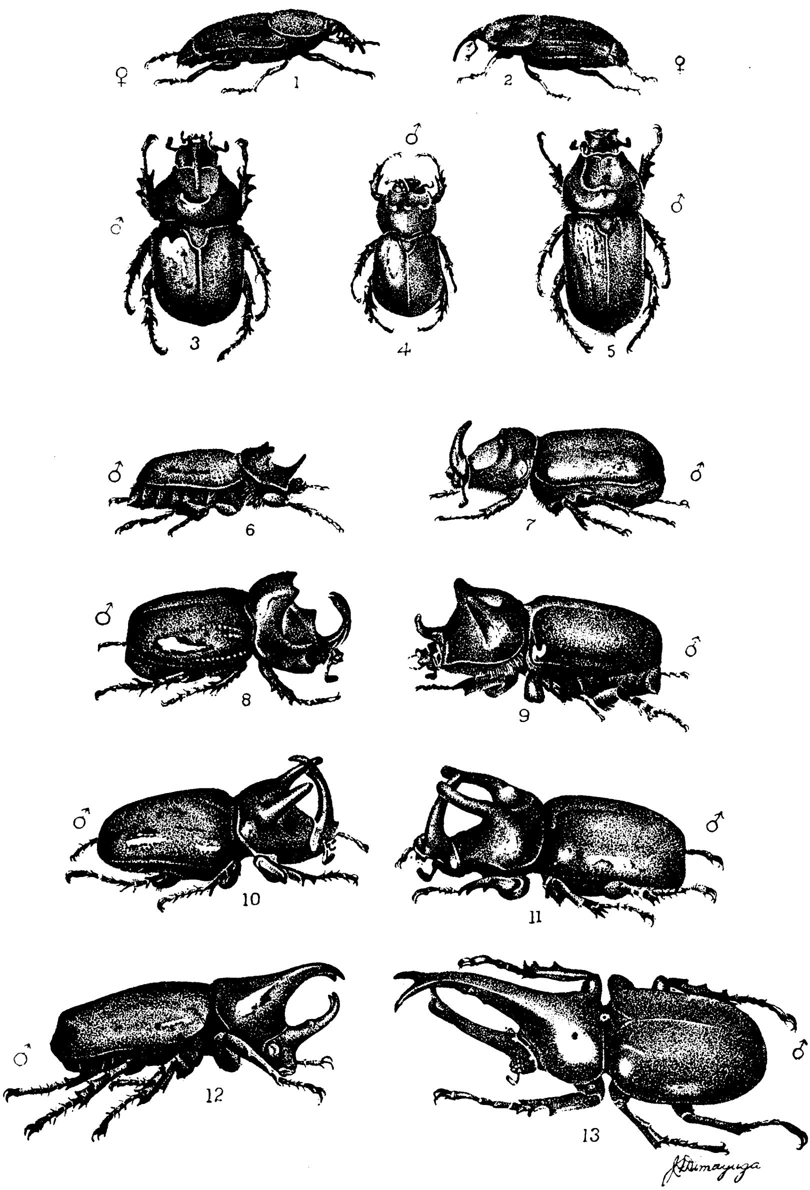
The coconut insect pests, according to their importance, their feeding habits and the methods of their control, may be classified into (1) boring insects, (2) leaf-eating insects, and (3) sucking insects.

BORING INSECTS.

The uang, *Oryctes rhinoceros* L. (Pl. XVIII 7, and XVII *a*) with the dalipos, *Rhynochophorus ferrugineus* Oliv., (Pl. XVIII 2, and XVII *b*), shares the distinction of being one of the two most deadly insect enemies of the coconut palm in the Philippines if not in the world. According to D. B. Mackie, formerly entomologist of this Bureau, the annual loss of coconut trees in the Philippines due to the uang totals ₱6,000,000.

The eggs are laid in decaying vegetable matter, such as rotting tree trunks or stumps, manure or rubbish. The larva, somewhat horseshoe shaped, is a dirty white in color, soft and fleshy, with a blackish head, and ultimately attains a length of sometimes 10 centimeters and is up to more than 25 centimeters thick, before pupation. According to Gosh, about one year is passed in the larval and pupal stage. The adult uang, or rhinoceros beetle, as it is also called, is in the male from 40 to sometimes 60 millimeters, in the female 35 to 40 millimeters long, black or dark brown and shining above, and lighter brown beneath. The head is comparatively small, with stout and strongly toothed mandibles that the beetle uses in tearing apart the tissues of the palm in the course of burrowing in the tree, and provided with a conspicuous curved horn, frequently 10 millimeters long in large male beetles, back of which, in the thorax, is a large concavity.

Unlike most insects, which are most destructive in the larval stage, the uang is harmless until it becomes an adult. The full-grown beetle feeds upon the juice of the tender, sappy tissue of the trunk or the heart of the coconut and several other palms, such as the royal palm, date, buri and even the pandan, and lights in the crown between the leaves and eats its way into the trunk, sucking out the sap from the torn tissues. The result of the attack of coconut trees by the uang is well illustrated in Plate XIX. Nut production receives a serious direct check, the trees are weakened and ultimately die if no steps are taken to control or eradicate the pest. Aside from its direct injury to the coconut palm the uang prepares the way for the attack on



Coconut beetles.

1. *Rhynchophorus signaticollis* Chevc. India.
2. *Rhynchoporus ferrugineus.* Oliv. Indo-Malaya.
3. *Oryctes boas* Fairm. East Africa.
4. *Cameionotus quadrituber* Fairm. New Guinea.
5. *Oryctes monoceros* Ol. East Africa.
6. *Strategus anachoreta.* Tropical America
7. *Oryctes rhinoceros* L. Indo-Malaya.
8. *Oryctoderes latitarsis* Burm. New Guinea.
9. *Trichogomphus semilincki.* New Guinea.
10. *Scapanes australis* Bois. Indo-Malaya.
11. *Scapanes grossepunctatus Sternb.* New Guinea.
12. *Xylotrupes gideon* L. Indo-Malaya.
13. *Xylotrupes lorquini.* New Guinea.

the trees by the dalipos, or red beetle, generally conceded to be the most serious of these two insects.

Remedies.—Since the coconut became a plantation crop, various remedies, repellants, direct destruction of the insects and traps have been tried to control or eradicate the uang. Many of these have failed to accomplish their purpose; others have been found of practical application.

So far as known the uang cannot be fought to advantage by means of spraying, poisoning, or repellants. There remain then direct destruction of the insect by hand, trapping, and natural predatory agencies, in the way of fungi, bacteria, insect or animal enemies.

Considering its breeding habit, the uang is most vulnerable in the larval stage. As a primary measure no decaying vegetable matter, manure or rubbish should be allowed to accumulate in the plantation or thereabouts; stumps and dead trees should be removed or burned.

The experience with the uang in foreign countries indicates that the most practical way to destroy the beetle is to dig pits about 100 meters apart 3 to 4 meters square, and 0.75 meters deep. The pits should be filled with palm trunks, decaying wood, leaves, and manure until it forms a mound about 30 centimeters above the ground. Here the beetles gather and deposit their eggs. The pits should be opened once every two months and the larvae killed. If the pits were lined with clay in the bottom and on the sides, the larvæ could be readily destroyed by pouring bisulphide of carbon into the pits at intervals as stated.

As a supplementary measure the trees should be inspected every six weeks to two months and the flying beetles killed. This can best be done by the aid of a sharp-pointed, stout wire or iron rod which is used to probe the holes in the coconut tree. After the beetles have been killed the holes should be filled with a mixture of sand and coal tar to prevent its furnishing a breeding place for the dalipos, or red beetle.

So far as the author is aware only two natural enemies have been reported on the uang.

In Samoa, Friedrichs employed a fungus to destroy the grubs in the pits used as traps, but later reports relative to the usefulness of this agent are very contradictory and its value as a parasite cannot be said to have been definitely demonstrated.

During a visit to Zamboanga and Jolo in April, 1917, Mr. F. Warner, division superintendent of schools, Siasi, Sulu, related to the author that there is in the interior of the Island of Bohol

a flying lemur, *Galeopithecus* sp., known under the Visayan name "caguan," which has been domesticated by the Filipinos, and is bred partly for his skin, which is used locally for making hats, and partly to catch coconut beetles.

The caguan is described as being 60 to 70 centimeters long, of low stature, mouse gray to golden brown in color with white markings on the sides underneath. The animal is insectivorous, being employed as stated to catch uang, but it also feeds on the leaves of Jak, *Artocarpus integra* L, this being the only plant food eaten by the caguan so far as known. The flesh of the caguan is poisonous to dogs, which vomit it after eating, and this is probably true of other carnivora. So far as known the animal has no objectionable habits considering that no other natural enemies to the uang are known that may be effectively used in its control, the life history of the caguan may be well worth investigating.

Other species of *Oryctes* that have been reported more or less destructive to the coconut palm are *O. anglias, O. boas* Fairm. (Plate XVIII, 3), *O. colonicus* Coq., *O. insularis* Coq., *O. cristatus,* Snell, *O. ravanalo* Coq., *O. monoceros* Oliv., (Plate XVIII 5), *O. Preussi; O. pyrihus* Burm.

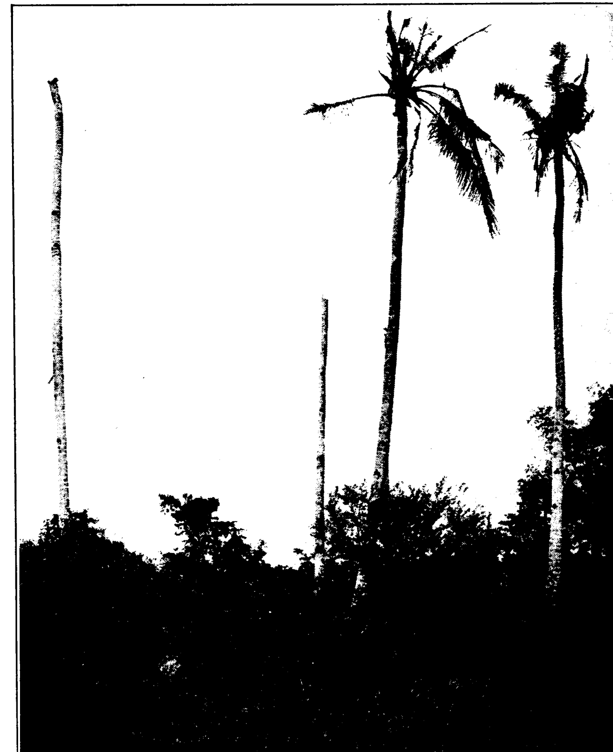
Other related beetles that attack the coconut in a similar way to the uang are *Camelonotus quadrituber* Fairm. (Plate XVIII, 4), *Oryctoderes latitarsis* Burm. (Plate XVIII 8), *Xylotrupes gideon* L (Plate XVIII, 12) ; *X. Lorquini,* (Plate XVIII, 13), *Trichogomphus semilincki* Ritz. (Plate XVIII, 9), *Scapanes australis* Bois. Plate XVIII, 10), *S. Grossepunctatus* Sternb. (Plate XVIII, 11), *Strategus anachoreta,* (Plate XVIII, 6), *Eurytrachelus pilosipes* Waterk, *E. intermedius,* and *Passalus tridens.*

The life habits of all these beetles are very similar and they may therefore be destroyed in much the same way as the uang. Some of these insects have been recorded in the Philippines but not as serious coconut pests.

Barrett says: "Perhaps the most insidious trunk infesting coconut pest in the world is the terrible little sericorn beetle, *Melitomma insulare,* of the Madagascar and Seyschelles region. This insect enters the stem at the base among the roots, and, partly by its own voracity and, it is thought, by reason of caustic liquid excreted by the larva, soon kills the tree."

The second most important insect pest of the coconut in the Philippines is a weevil, the dalipos, *Rhyncophorus ferrugineus* Oliv. (Plate XVIII, 2 and XIV *b*), also known as the red beetle. Some authors consider it even more dangerous than the uang, with which it must not be confused. The dalipos, a name applied

(*a*) Coconut trees attacked by the "uang."



(*b*) The last stage of the trees after a beetle attack.

to this weevil in some parts of the Philippines, occurs from Ceylon and India through Annam, Burma, the Federated Malay States, the Philippines, and the Sunda Isles to New Guinea. It is variable in size and color from 30 to sometimes exceeding 40 millimeters in length, from a brownish dull red to dark brown, with dark spots on the lighter colored thorax, and a long slender snout.

The larva is pale yellowish, and attains a length of up to 60 or more millimeters burrowing the heart or in the soft, sappy tissues of the trunk of the palm, in which it spins a cocoon and, according to Gosh, it emerges as a full-grown insect after a period of about 75 days from the laying of the eggs, of which 25 are passed in the pupal stage. As a matter of fact the life cycle of the dalipos is quite variable, sometimes being much shorter than 75 days and again it may be appreciably longer. As may already be understood from the above, it is the larva of the dalipos that is destructive. The full-grown weevil itself is a harmless, shy insect that disturbed feigns death.

The dalipos lays its eggs in the soft tissues of the trunk near the crown or in the *heart* of the palm, that have previously been exposed through mechanical injury by the careless handling of the bolo, from typhoon injury or in the burrows already made by the uang. More rarely is it found in the lower, older part of the trunk of the palm. Perfectly healthy uninjured coconut palms are never attacked by the dalipos. It is the fact that the uang, so to speak, prepares the way for the dalipos and makes possible an attack of a tree by the weevil, which makes the uang doubly dangerous both in a direct and indirect way.

Scolia erratica Smith has recently been reported parasitic on the dalipos in the Federated Malay States by Burkhill. This *Hymenopter* occurs also in Java, Sumatra, Sikkin, and Burma.

Remedies.—Trees that are found infested with the dalipos should be cut down and disposed of either by burning or throwing them in the river or ocean, depending upon location.

Traps may be set of the adult egg-laying weevils by cutting down other native palms, the trunks of which should be cut up in convenient length and split, and placed together with small piles of rubbish here and there in the infested area. Each morning the rubbish piles should be examined and the weevils collected and killed. After an exposure of two weeks the bait should be burned so as to kill the larvae that may have developed from eggs laid therein.

Other weevils that attack the coconut more or less severely in various countries the remedies for which correspond to those

recommended for the dalipos are: *Rhynchophœus signaticollis* Chevr. (Plate XVIII, 1), *R. pasha* L., *R. phoenicis, Sphenophorus obscurus* Boisd., *Metamasius hemipterus* L., *M. cinnamominus, Rhina barbirostris, Calandra taitensis* Guerin, and species of *Rhabdobaenus* and *Cyrtotrachelus.*

LEAF-EATING INSECTS.

The leaf-eating insects include beetles, *Lepidoptera* and locusts. In the Solomon Islands, *Brontispa froggatti* Sharp, and in the New Hebrides, *Promecotheca opacicollis* Gestro, both beetles, have proved destructive to the coconut. *P. cumingii* occurs in the Philippines, *P. coeruleipennis* Blanchard, in Fiji and *P. antiqua* Weise, in New Guinea, but neither are regarded as serious pests.

Among the lepidopterous coconut pests in the Philippines may be mentioned *Padraona chrysozona* Plotz., and *Thosea cinereamarginata* Banks, *Levuana iridescens* B. B., *Brachartonia catoxantha* Hemp., *Bressolis isthmia, B. sophorae, Hidari irawa, Nephantes serrinopa* and *Omiodes blackburnii,* are found in various other coconut-growing regions. The damage of these insects is, of course, caused in their larval stage.

At least two Phasmidae, or "walking sticks," *Graeffer cocophagus* Newport, and *Hermarchus pythonius* Westw., are known to feed on the leaves of the coconut palm but like the *Lepidoptera* they are only of local importance and scarcely serious.

Remedies.—Where leaf-eating insects appear on the young plants a spraying with formula No. 5 is recommended. This is a poisonous spray and the insects are killed in eating the poisoned leaves. The contact sprays in formula 2, 3, and 4 might be used to advantage in isolated instances. Handpicking is a slow method of destroying the insects. Nevertheless it may be used where spraying cannot be conveniently employed. Tobacco water may also be found useful.

In the outbreak of locusts coconuts are attacked in common with the cereals, rice, and corn, and sugar cane, and in large numbers they cause serious damage to the coconut trees by defoliating them (Plate XVII *b*).

Remedies.—Reforestation of the cogonales and grass lands is recognized as the only permanent remedy for the locusts. Very little can be accomplished with the full-grown flying locusts except to drive them off, and unfortunately, it is in this stage principally that they are a menace to the coconut. For a full discussion of locusts and their control see circular No. 23 of this Bureau.

SUCKING INSECTS.

These insects derive their name from the fact that they sustain themselves by sucking the juices of the plant upon which they prey. All the sucking coconut pests are scales or related insects. Only one of these has so far been reported as a serious menace to the coconut, *Aspitiotus destructor* Sign., a small, round scale not quite a millimeter across, related to the San José scale. This insect has from time to time been reported to inflict considerable damage upon young coconuts both in the Philippines and other countries.

The following is a list of the scale insects known to infest the coconut palm: *Aleyrodicus destructor* Quaint, *A. cocois, Aspidiotus articulatus* Morg., *A. cocotiphagus Marlatt, A. cydoniae punicae* Ckl., *A. destructor* Sign., *A. latania* Sign., *A. palmae* Ckl., *Asterolecanium lineare* Lindl, *Ceroplastes actiniformis* Green, *Chionaspis candida* Banks, *Chrysomphalus candida* Banks, *Chrysomphalus sonidum* L., *C. aurantii* Mask., *C. personatus* Comst., *C. propsimus* Banks, *Coccus acutissimum* Green, *Diaspis boisduvalii coccois* Licht., *D. vandalicus* Galvez, *Fiorinia fioriniae* Targ., *Furchaspis oceanica* Lind, *Hemichionaspis aspidistrae* Sign., *H. monor* Mask., *Lepidosephe gloveri* Pack., *L. unicolor* Banks, *L. McGregory* Banks, *Pinaspis buxi* Bouche, *Pseudococcus cocotis* Mask., *P. virgatus* Ckl., *P. pandani* Ckl.

Remedies.—As a rule none of the above-mentioned scales except *Aspidiotus destructor* appears as a pest, and even the attacks of this scale are sporadic and local. The scale insects are usually kept well in check by their natural enemies. Where they appear in destructive numbers they may be readily controlled by spraying with formulas 2, 3, and 4 once or twice at intervals of about three weeks, if necessary. The more seriously scale-infested leaves should be cut away and burned.

MISCELLANEOUS PESTS.

Fortunately the flowers and young fruits of the coconut are practically free from destructive pests. An exception is a bug, *Axiagastus cambelli* Dist., described from the Solomon Islands. If appearing in dangerous numbers, this sucking insect could probably be controlled by spraying with formulas Nos. 2, 3, or 4.

Mycterophallus xanthopus Boised., has been reported to destroy the flowers in the Philippines but is not considered as a coconut pest.

In devouring the decaying nuts, termites, *termes* spp., sometimes are apt to cause damage to the young plants.

Remedies.—Their nests should be broken up and destroyed wherever they are found.

On large estates, where termites are found troublesome, the cheapest and simplest way of ridding the land of termites is perhaps to use carbon bisulphide, poured into the nest through a hole made by the aid of a crowbar, which is plugged up after the carbon bisulphide has been poured in.

Termites may also be destroyed by the fumes of arsenic and sulphur introduced into the galleries of the termites by means of an ant exterminator. This apparatus consists of a charcoal burner and fume chamber and a handpump connected by a

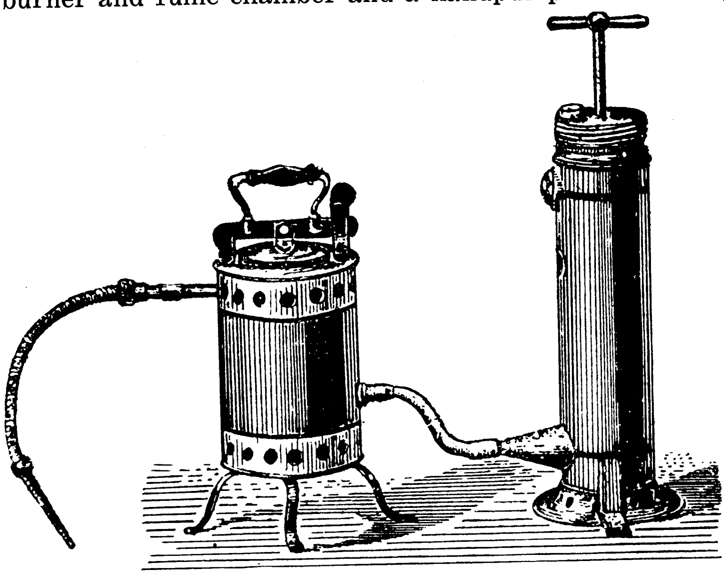


FIG. 5. Ant exterminator.

rubber hose. After the burner is lighted the air is pumped into the fume chamber, from which the charge of poisonous gas is forced into the termite nest. About a heaping spoonful of sulphur and arsenic is sufficient to treat a termite nest of ordinary size, and pumping for about 5 minutes is sufficient to introduce the fumes.

Among the larger enemies of the coconut is the robber crab, *Birgus letro,* which is not satisfied only with husking fallen nuts, but actually climbs the coconut trees and throws down the nuts. Because of its size it could easily be hunted down and destroyed if appearing in large numbers.

Various species of rats are also troublesome sometimes, but where necessary they may be controlled by the distribution of poisoned bait.

Crows peck holes in the young nuts for the sake of the milk. The use of firearms is here the only practical remedy. This is true also of bats, flying foxes, and monkeys, which now and then are destructive.

Wild pigs are exceedingly destructive to young coconuts wherever they are present, and the starting of a plantation without a hog-proof fence in a locality where these animals occur would be useless.

SPRAYING.

In order to be effective, the spraying should be thorough and the application liberal, and the pressure should be sufficient to cause the spray to settle on the plants as a fine mist and not in large drops. This is important in spraying any plant but it is peculiarly so in spraying palms because of their habit of growth. *Heavy spraying so that the spray collects and runs down into the bud should be guarded against or the trees may be seriously injured or even killed by the mixture.*

It is important that the spray mixture be well strained in order to prevent the nozzles from becoming clogged in the act of spraying. It is also well to remember that copper sulphate and the arsenates are very poisonous and should not be left where they are accessible to children or domestic animals.

The arsenical sprays are employed in the destruction of biting insects that eat the poisoned leaves. The oily sprays or those containing sulphur are commonly referred to as contact sprays because they kill the insects by contact. Therefore, it is very important that the latter class of sprays be sprayed *on the insect whose destruction is contemplated,* as the spraying of the plants themselves is ineffectual.

Thoroughly rinse out the spraying implements with clean water when the spraying is completed.

A barrel sprayer (fig. 6) mounted upon a cart will be found the most serviceable spraying implement on a moderate-sized plantation.

FORMULAS FOR FUNGICIDES, INSECTICIDES AND WEEDICIDES.

FOR FUNGI.

No 1.—*Bordeaux mixture.*

Copper sulphate	kilograms	1.5
Unslaked lime	do	1
Water	liters	100

Place the copper sulphate in a coarse sack and suspend it in a barrel containing 50 liters of water so that the sack is entirely

covered by water. Slake the lime in another vessel and when slaked dilute to 50 liters. Before mixing, stir the two solutions vigorously. Then dip a bucket from each solution and pour the two liquids together in a spray barrel, at the same time agitating the mixture vigorously. An excess of copper sulphate is injurious to the foliage, and, before spraying, the mixture should therefore be tested. This is done by inserting and holding in the mixture a clean steel blade for one or two minutes. If copper is deposited on the blade, more lime must be added. Use the mixture at once.

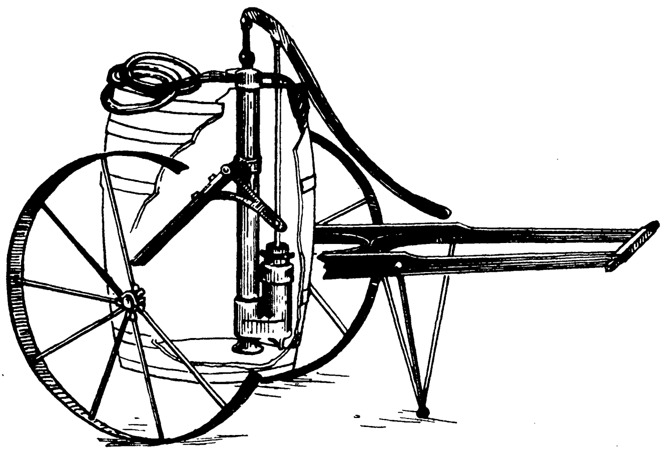


FIG. 6. Spray barrel.

FOR SCALE AND SUCKING INSECTS.

No. 2.—*Kerosene emulsion.*

Kerosene	liters	7.5
Hard soap	kilogram	.25
Water	liters	4

Dissolve the soap in boiling water and, while still hot, add the kerosene. Churn the liquid steadily for fifteen or twenty-minutes by using a force pump, the liquid being pumped back into the vesesel until it is emulsified. Sufficient hot water should be added to increase the volume of the solution to 16 liters. For spraying, dilute at the rate of 1 liter of the stock solution to 15 to 20 liters of cold water.

FOR SCALE AND SUCKING INSECTS.

No. 3.—*Resin wash.*

Resin	kilograms	9
Caustic soda (98 per cent)	do	2.25
Fish oil	liter	1.5
Water	do	75

Pour 75 liters of water over the resin (which should be well broken up), caustic soda, and fish oil in a large iron kettle and boil for three hours. Then add hot water from another boiler (which should be provided for this purpose) from time to time, and stir thoroughly until there are 190 liters of the solution. If desired for immediate use, dilute each liter of the solution with 2 liters of cold water before using. If kept as a stock solution, it should be diluted at the same ratio when used.

FOR FUNGI AND SCALE.

No. 4.—*Self-boiled lime-sulphur wash.*

Quicklime	kilograms	3
Sulphur (flour or flowers)	do	3
Water	liters	100

Place the lime in a barrel and pour on enough water to cover it. When the lime begins to slake add the sulphur after running it through a sieve to break the lumps. Stir the mixture constantly and add water as needed to form a thick paste at first and then gradually a thin paste. The lime will supply enough heat to boil the mixture several minutes. As soon as the lime is well slaked add water to cool the mixture and prevent further cooking. Strain carefully, working the sulphur through the strainer and dilute to 100 liters.

FOR BITING INSECTS.

No. 5.—*Arsenate of lead.*

Arsenate of lead	kilograms	0.5–1
Quicklime	do	.5–1
Water	liters	100

Slake the lime in a wooden vessel, dilute to 100 liters, and dissolve the arsenate of lead in the liquid.

FOR WEEDS.

No. 6. *Arsenite of soda.*

Arsenite of soda	kilograms	1
Water	liters	.40–.70

Dissolve and spray of—

White arsenic	kilograms	1
Washing or sal soda	do	2
Water	liters	8

Pour the water over the arsenic and soda in a kettle and boil for 15 to 20 minutes, or until the mixture is clear. The clearing of the solution indicates that the proper chemical combination has been affected. Dilute at the rate of 1 part of the stock solution to 14 to 24 parts of water and spray.

CURRENT NOTES—FIRST QUARTER.

Notes by P. J. Wester, Agricultural Advisor, Department of Mindanao and Sulu.

A NEW METHOD OF ROOTING DATE PALM SUCKERS.

In common with other fruit trees, the date palm does not come true to seed, and where date growing is a business the various cultivated varieties are propagated by severing the offshoots, or suckers as they are commonly called, and planting them. This has been the custom of procedure from time immemorial by the growers in the date regions of Asia and Africa, and has been followed by the American date growers in California and Arizona, who have, however, we learn from J. Eliot Coit, in the Journal of Agriculture, been greatly disappointed by the indifferent results obtained by this method of propagation.

The war had shut off the usual source of supply of suckers in the old world, and the scarcity and high prices demanded for date plants led to experimentation in California, with a view of improving upon the old above-mentioned method of propagating the date.

According to Mr. Coit, the problem has been solved very satisfactorily by building practically air-tight propagating houses, except for the top. In California these date propagating houses are 6 meters wide and any length desired running east and west; they are made 2.4 meters high on the north side and 1.8 meters high on the south side. The sides are constructed of boards 25 millimeters thick, covered by black roofing paper on the outside. The roof or cover is made of 8-ounce duck. Some growers are said to use cloth instead of boards for the wall on the south side, which admits more light and therefore induces the plants to make a more robust growth.

The soil in the propagating house, which has no floor, should be sandy, well drained and level. In placing the suckers care should be taken not to set them so deep that water collects and stands in the butt or "heart." Water is applied every other day.

The new method of propagating dates is said to be very satisfactory.

LITTLE KNOWN CHILEAN FRUITS.

The following fruits growing in Chile, but little or not at all known in other countries, are enumerated in the International Review (Rome) which might be introduced to advantage into the Philippines:

Macqui, *Aristotelia macqui,* the fruit of which is eaten raw or prepared in various ways. Murtillo, *Ugni molinae,* a myrtaceous shrub considered to be one of the best native fruits. Parilla, *Ribes magellanicum,* with bunches of black berries. Others mentioned are the Huarapo, *Myrteola leucomyrtillus,* Hiñemiñe, *Rubus camaropis radicans,* Zarzamora, *Rubus ulmifolius,* Coguiles, *Lardizabala biternata,* Sabinella, *Margyricarpus setosus,* Quilo, *Muehlenbeckia chilensis, Berberis buxifolia, Empetrum rubrum, Rubus geoides, Greigia sphacelata,* Copihue, *Lapageria rosea,* Doca, *Mesembryanthemum aequilaterale,* and various unidentified species belonging to the genera *Cereus, Eulychnia, Ephedra, Pernettya,* and *Gaultheria.*

The native Chilean vegetables are few and of little importance. There are several edible fungi, of which *Agaricus campestris* is said to grow "in enormous quantities north of Punta Arenas." *Durvillaea utilis,* a large marine algae, is also used for food by the people.

GRAFTING EXPERIMENTS.

The International Review (Rome) reviews a paper by J. B. Dental, published in Revue Horticole (Paris) in which the author discusses his experience in grafting various species of plants. Mr. Dental found *Grevillea robusta* a satisfactory stock for *Grevillea asplenifolia, G. preissii, G. banksii, G. hillii, G. drummondii, G. rosmarinifolia, G. alpestris, G. macrostylis, G. sulphurea, Macadamia ternata, Hakea eucalyptoides* and *H. pinifolia.* He has also grafted *Araucaria bidwillii* on *A. excelsa; Ficus roxburghii* and *F. australis variegata* on *F. rubiginosa; Raphiolepis del acourii* on *Cydonia vulgaris; Rephiolepis indica* on *Eriobotrya japonica; Callitris australis* and *Juniperus pachyphlae* on *Cypressus pyramidalis; Tacsonia* on *Passiflora cœrulea* and *P. floribunda; Bougainvillea brasiliensis* on *B. sanderiana.*

In grafting *Iris germanica* on *I. pallida,* Mr. Dental is undoubtedly the first man to demonstrate that endogenous plants can be grafted.

In connection with the above statement about the grafting of the *Ficus,* it may be of interest to record that the writer budded the fig *Ficus carica* on *Ficus aurea* Nutt., in Miami, Florida, in

1908, but the buds did not make a good growth. It is quite possible, not to say probable, that extended experimentation along this line with the almost innumerable tropical species of the genus *Ficus* would result in the discovery of a suitable stock for the fig, with the possible further extension of the cultivated area of the figs toward the equator.

POTATO PRODUCTION IN JAVA.

The diversification of crops in Java has been alluded to in a previous issue of the REVIEW, and the efforts made by the Dutch government to develop all the natural resources of the island, not to say create new ones, and to make it self-sustaining. The production of potatoes for local consumption and even for export is one of the evidences of this work of the government. In 1917 the Philippines imported potatoes to the value of about ₱800,000, mostly from Japan. Potatoes of good quality have been grown at medium and high elevations in Lanao, Mindanao, and in the Mountain Province and Nueva Vizcaya in the Island of Luzon. Especially good potatoes have been produced in Bayombong, Nueva Vizcaya, but the cost of transportation to Manila is too great at present to make potato growing in Bayombong a profitable undertaking. This is equally true of the Mountain Province also.

BUREAU OF AGRICULTURE STAFF.

First Row, Mack Cretcher, Assistant Director; Adriano Hernández, Director of Agriculture; J. G. Sanvictores, Assistant Director.

Second Row, standing, left to right: S. Apostol, Chief Plan Industry Division; S. Youngberg, Chief Veterinarian; D. D. Strong Chief Fiber Division; Mar. Billedo, Chief Demonstration and Extension.

Third Row, standing, left to right: A. Tuazon, Asst. Chief Animal Husbandry Division; W. G. Frisbie, Chief Publications Division; C. W. Hines, Sugar Technologist: A. W. Prautch, Chief Rural Credits Section.

THE PHILIPPINE

Agricultural Review

VOL. XI SECOND QUARTER, 1918 No. 2

CONTENTS.

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PHILIPPINE AGRICULTURE.

GENERAL SUMMARY.

Among the activities of the Bureau of Agriculture for the year of 1917, deserving of special attention, are: First, the big food production campaign carried on by the Bureau under the direction and supervision of the Secretary of Agriculture and Natural Resources, including unprecedented activities in seed and plant distribution, a campaign for rice seed selection, the establishment of nurseries and demonstration plots, home gardens, increased interest in live stock, especially hogs and poultry, and a general awakening of the people to the seriousness of the situation due to the world war. Second, the remarkable advancement made in the establishment of rural credit societies among the small farmers of the Islands, which has exceeded the expectations of even its most enthusiastic supporters. Third, the elimination of the locust plague, a condition never before attained in the history of the country. Fourth, the satisfactory progress of the inspection and grading of fiber and the establishment of stripping machines for maguey fiber and the campaign for increased production of this important product. Increased prices for copra, coconut oil, fiber, corn, live stock, rice and all farm products with the possible exception of sugar, have given an increased prosperity to the farmers and to the country as a whole, which bids fair to advance materially during the coming year. Failure to check the ravages of rinderpest is the one drawback for the year of 1917, the loss of work animals proving a serious handicap to agriculture, and the prevalence of the disease absolutely prohibiting any attempt at establishing the much needed coöperative work animal insurance provided by Act No. 2573.

THE FOOD CAMPAIGN.

The energies of the Bureau throughout the year have been centered on the food campaign as the one matter of most pressing importance to the country, due to the war in Europe and the possible food shortage. The appointment of a Government Food Commission which took over the direction of the big campaign for increased production of food products did not lessen the activities of this Bureau, but rather served to stimulate effort, and there has been the heartiest coöperation in carrying out

the plan for food production as outlined by the Food Commission and under its immediate supervision and direction, not only in creating interest in increased live-stock production, home gardens, poultry, field demonstration, coöperative plots, nurseries, lectures by the field men and chiefs of divisions of the Bureau, but also by the distribution of seed and plants on a scale never before attempted by the Bureau of Agriculture, and by the inauguration of a campaign for rice seed selection by forces of trained men in the farmers fields at harvest time, this campaign extending to most of the leading rice-producing provinces of the Islands. Some idea of the magnitude of the seed distribution of this Bureau may be gained from the statement that during the year 1917 a total of 77,527.5 kilos of field and garden seeds were sent out, consisting of 2,931,894 in separate packages besides the seed distributed in bulk. This seed was secured at an approximate cost of over ₱34,000 and an estimated retail value of about ₱300,000. During the past year 6,676 tropical fruit trees of various species, 41,005 coffee seedlings representing 10 varieties and 108,447 various other plants and cuttings were distributed from the Lamao Experiment Station alone, and 688,709 various kinds of economic plants, cuttings, bulbils and suckers were sent out from the Singalong Station.

RURAL CREDIT.

As previously stated, the remarkable growth and activity or rural credit association throughout the provinces has exceeded the expectations of its most enthusiastic champions, and has proven one of the most gratifying and far-reaching achievements of the Bureau during the past year. The movement was in its infancy during the closing days of 1916, but eight rural-credit associations having been formed, up to January 1, 1917. On January 1, 1918, there were 84 regularly organized associations with a combined capital stock of ₱409,880, of which ₱41,483 had actually been paid at the time of incorporation, which sum has been greatly increased, a conservative estimate placing the paid up capital of these associations at close to the ₱100,000 mark at the close of 1917. In addition to the associations already incorporated, 142 other associations were organized during the year, the capital of which has not been entirely paid in, thus for the present delaying their incorporation. The year's results are encouraging. A mean has been found whereby the small farmers may be enabled to help themselves by coöperation. Only a fair start has been made as yet but a knowledge of the plan is spreading rapidly and is being readily accepted.

It is sure to grow if carefully managed because rural credit meets an urgent and pressing need.

LOCUST EXTERMINATION.

It is a source of great satisfaction to be able to announce that the Islands are now free from locust invasions and have been thus free for a period of several months. On July 28, 1917 the Archipelago was declared free of locusts, and except for a few scattered swarms that were promptly destroyed upon their appearance, the country has been free ever since, and from September 22, 1917, no locust swarms have been reported anywhere in the Archipelago, a condition that has not existed before during modern times.

THE FIBER INDUSTRY.

Fiber grading and inspection during the year was conducted in a most satisfactory manner. During the year, 34 grading stations and 101 grading establishments were designated, and increase of 4 stations and 4 establishments over the previous year. Of the 101 establishments, only 24 still use special house marks for each grade of the Government standard. Government inspectors during the year inspected, stamped, and approved 1,291,851 bales of abaca (Manila hemp), 113,579 bales of maguey and sisal and 1,553 bales of pacol and canton. A total of 21,228 bales of abaca and maguey were rejected as not being up to the proper standard. A grand total of 1,406,983 bales of fibers of all classes were produced during the year, an increase of 101,831 bales over the total of the previous year. In order to stimulate the production and increase the quality of maguey fiber, two Prieto fiber extracting machines were purchased and installed at the Singalong Experiment Station, where extensive experiments and tests were made before sending the machines to the provinces for demonstration work. The results obtained were very satisfactory, and fiber experts assert that these machines will give good results and greatly increase the maguey industry throughout the Islands and place it on a more staple basis.

CROP CONDITIONS.

The following report on crop conditions is for the year ending June 30, 1917. The figures given are preliminary and are subject to more or less alteration in the final estimates of the statistics section.

The agricultural year, June 30, 1916, to June 30, 1917, was an exceptionally good one for nearly all staple crops. During the year only one typhoon of importance visited the Islands,

passing over the northern part of Luzon and the Babuyanes group. Storms of lesser degree were reported in northern Mindoro, northern Samar, southern Sorsogon, Balintang Channel and a few other localities, but little damage to crops resulted. Heavy rains fell during the year in nearly all parts of the Islands, but particularly in Mindanao, the Visayas and northern Luzon, causing rather heavy damage to sugar cane, tobacco, and corn, although the damage by rains and floods was not so great as in the previous year. The greatest damage reported was that of the sugar crop in Negros and Panay, yet the excessive rains there were favorable to coconuts, abaca, rice, and maguey.

In last year's annual report the prediction was made that in view of good crop prospects and probable advance in prices, the total value of the nine staple products of the Islands for the year 1916–17 would come close to the ₱200,000,000 mark. It is gratifying to state that this prediction has been more than realized, the total value of crops for this period being ₱234,000,000. This remarkable increase as compared with the ₱181,700,000 for the previous year of 1915–16, ₱160,419,060 for 1914–15, ₱165,013,832 for 1913–14 and ₱178,639,668 for 1912–13, is due to to some extent to increased production, but in a greater degree to the great advance in prices.

Rice.—During the year there were harvested, in round numbers, 1,939,000,000 liters of rough rice, worth ₱72,500,000, which represents an increase of over 23 per cent above last year's production and nearly 30 per cent over the value of the crop of the previous year.

Abacá.—Next in value comes abacá with a production of about 155,730,000 kilos, which is only an increase of about 1 per cent in production over the previous year, yet showing a total value of ₱60,722,000 which is an increase of nearly 42 per cent over the value of the previous crop.

Coconuts.—The total value of this crop amounted to ₱32,860,000 or ₱8,430,000 more than was paid for the previous crop, the yield being 887,000,000 nuts and 42,600,000 liters of tuba. Of the total number of nuts, 63,360,000 were used for food and the remainder were used for copra and coconut oil, producing 186,227,000 kilos of copra and 2,600,000 liters of oil. Compared with the previous year, there is an increase of thirty-one per cent in copra and 3 per cent in oil.

Sugar.—The production of sugar was 365,000,000 kilos of crude sugar and panochas, worth ₱32,850,000, which shows a decrease of 2 per cent as compared with the crop of 1915–16, due mostly to continuous heavy rains.

Corn.—This crop also registers a decrease of nearly 5 per cent in production compared with that of last year, but the crop in worth approximately 20 per cent more than that of last year, the total value being ₱17,640,000.

Tobacco.—The total tobacco production was 47,000,000 kilos worth ₱11,637,000, which is an increase of fourteen per cent in production and a gain of ₱4,378,000 in value over the crop of the previous year.

Maguey.—The production of maguey this year was 23,629,000 kilos, valued at ₱4,962,000 an increase of 76 per cent in production over the previous year and of 184 per cent in the value, a creditable showing indeed, and one which shows the possibilities and growing importance of this valuable product.

Cacao and Coffee.—These crops of relatively minor importance show an increased production for the year. The yield of cacao was approximately 600,000 kilos, and of coffee 800,000 kilos, with a value of ₱382,000 for cacao and ₱397,000 for coffee.

CROP PROSPECTS.

From present indications, the new agricultural year of 1917–18 will be the most successful year ever recorded for all crops with the possible exception of sugar. It is estimated that the total rice production for the coming year will be close to 30,000,000 cavans of rough rice if the season continue favorable, yet in spite of extraordinary increase in production during the past year and the promises of even greater production for 1917–18, there is a steady advance in the price. Prices of cleaned rice per cavan in December, 1916, in the following rice centers, were: Nueva Ecija, ₱6 to ₱6.20; Tarlac, ₱6; Pampanga, ₱6 to ₱6.20; Bulacan, ₱6.20 to ₱6.40; Iloilo, ₱6.60 to ₱7. In the same month of 1917 the prices were: Nueva Ecija, ₱7.40 to ₱7.50; Tarlac, ₱7.50; Pampanga, ₱9.50 to ₱10; Bulacan, ₱7.50 to ₱8; Iloilo, ₱7.50 to ₱8.40, an advance for the year ranging from ₱1.70 to ₱2.50 per cavan.

The serious damage to abaca and coconut plantations by the floods and typhoons of 1915 and early in 1916 have about disappeared, owing to favorable weather conditions since that time and to the care given plantations by the people who were encouraged by the constantly advancing prices. Many of the growing coconut trees are again coming into bearing and greatly increased production is predicted for 1918. It is also hoped that abaca production will show a satisfactory increase.

Considerable areas are being planted to maguey, a crop which is receiving particular attention at this time, owing to an over

increasing demand for this fiber, consequent profitable prices, and its adaptability to adverse climatic conditions. It is expected that many new areas will come into production during the year and under these splendid prospects an increase of at least 25 per cent in production may reasonably be expected.

Heavy production of tobacco is also expected. This crop is receiving great attention in many districts where it has heretofore been produced only on a small scale. Seed beds are already transplanted and the young plants are growing fine in most localities, all of which promises a large yield for 1918.

A norman crop of corn is expected, which will equal and may possibly show a slight increase over the figures for 1917.

Despite present unfavorable conditions in the sugar-producing districts of Negros and Panay, it is believed that the next crop will show an increase of from 5 to 10 per cent over the crop of 1916–17, as fairly good conditions are reported from the other sugar districts where large areas are in cultivation.

PERSONNEL.

There were no changes in the Directorate of the Bureau of Agriculture during the year of 1917. During the fiscal year, 14 American employees were appointed of whom 6 were permanent and 8 temporary. In the American personnel 32 employees were separated from the service through resignation during the year, 13 being from the permanent service and 19 being temporary employees, a reduction of 7 in the permanent personnel and 11 in the temporary list.

During the same period 521 Filipino employees were appointed, 80 being permanent and 441 were temporary, and there were separated through resignation 450 employees, of whom 20 were permanent and 430 were temporary, or an increase of 60 in the permanent personnel and an increase of 11 temporary employees. The increased force in the permanent personnel was due largely to the increased activities in the food production campaign and the Rural Credit section. It was also necessary to employ many livestock inspectors on account of the seriousness of the outbreak of rinderpest which continued unabated throughout the year.

ORGANIZATION.

There were no important changes in the organization of the Bureau during the year, only one new section being created, that of records section under the administrative division neces-

Residence of the Director of Agriculture at the Singalong Experiment Station.

sitated by the increased duties and importance of this work. Aside from this, the organization for the year has been practically that adopted August 1, 1916, at the suggestion of the efficiency committee and is as follows:

- Administrative division:
  - General Service section.
  - Accountancy section.
  - Records section.
  - Property section.
  - Publications section.
  - Statistics section.
  - Construction and Repair section.
  - American Colonies section.
- Animal Husbandry division:
  - Improved Breeding section.
  - Animal Selection and Distribution section.
  - Poultry Selection and Distribution section.
- Veterinary division:
  - Disease Control section.
  - Quarantine and Meat Inspection section.
  - Veterinary Research section.
- Plant Industry division:
  - Agronomy section.
  - Horticulture section.
  - Pest Control section.
- Fiber division:
  - Fiber Investigation section.
  - Fiber Inspection section.
- Demonstration division:
  - Agricultural Demonstration section.
  - Coöperative Organization and Marketing section.
  - Rural-credit section.
  - Insurance section.

ADMINISTRATIVE DIVISION.

GENERAL SERVICE SECTION.

The business of this section includes the general supervision of the stenographic work, dictation of official correspondence, general transportation supervision, keeping the efficiency records of all employees, supervision of property, accountancy and records, directly responsible to the chief of the administrative division, rental of buildings, light, water, janitors service, etc.

ACCOUNTANCY SECTION.

Eleven clerks were appointed to this office and eight were separated therefrom during the year. This section has recorded expenditures by projects and submitted monthly statements therefrom to chiefs of divisions and sections but this was discontinued on October 1, 1917. During the rest of the year only monthly statements showing the financial condition of each division were submitted.

This section is divided into subsections as follows: Collection and disbursement, auditing, requisition, colony accounts, bookkeeping, and general service. Each clerk is assigned to a particular work in each subsection but sometimes it was necessary to shift them from place to place where the work needed an immediate attention.

At the beginning of the year the Insular Auditor inaugurated a new system of classifying and journalizing accounts and keeping books. This system increased considerably the work of the bookeeping subsection.

RECORDS SECTION.

During the year there has been an increase of 108 per cent in the correspondence handled by this office over that of the preceding year. The work of the section has been increased greatly due to the activities of the food production campaign and the rural credit section. A spirit of excellent coöperation has prevailed among the employees of the section, a fact very essential in the administration.

No change has been made in the system of recording (vertical system) adopted by this Bureau four years ago. Although the system is not so efficient as that of the numbering system, yet the result has been satisfactory. The advantage of this system over that of the numbering system is that it requires much less money and personnel to carry out the work of the section.

Correspondence.—During the year there has been a total of 256,135 communications sent and received of which 230,405 lettters were outgoing and 25,730 incoming, as against a total of 122,592 communications sent and received during the preceding year, an increase of 133,543 or 108 per cent. Letters from school children and forms from our field men are not included. There were 11,797 letters delivered by messengers to different Departments and Bureaus in the city as against 7,352 in the preceding year. The cost for the transmission of cor-

respondence has been ₱7,189.64 for letters and ₱2,693.92 for telegrams, a total of ₱9,881.56, as against ₱7,330.36 in the preceding year, an increase of ₱2,551.20.

PROPERTY SECTION.

This section is in charge of the property of the Bureau of Agriculture. It accounts for the same and supervises all transactions in connection therewith. A system of ledger cards is used to represent the property accountability of the Bureau of Agriculture. These ledger cards are checked monthly with the books of the Bureau to insure the accuracy of the property accounts. In order to insure the correctness of the status of the property located at the various provincial stations as represented by the ledger cards, station superintendents are required to submit semiannual inventories of equipment and animals of their respective places. Nonexpendable property issued to employees is accounted for through memorandum and invoice receipts. Expendable property is likewise accounted for through a medium of supplies' cards which are in continuous check with the existing stock. No issue of supplies or equipment of whatever nature is made without properly approved requests. To facilitate the work of the section pertaining to the issue of supplies, equipment, etc., and to regulate the work on an efficient basis, issue of stationary, equipment, etc., to Central Office employees is made once a week only. Through this medium the work of the storeroom is being standardized. Thus, while one day is set for the issue of stationary, etc., to the Central Office force, the remaining working days of the week are set apart for the preparation for shipment of supplies, equipment, animals, and plant materials to the field employees of the Bureau and to private parties throughout the Archipelago.

All shipments of whatever nature, whether intended internally or for foreign ports are cleared through this office. While the routine clerical work is a little more than usual, the shipment of seeds and other plant materials were more than double as compared with the past year. The purchase of merchandise for the American Colony has also become a notable item in the work of this section.

PUBLICATIONS SECTION.

The work of this section embraces the publication and distribution of the Philippine Agricultural Review, a publication

in English, issued quarterly; the Philippine Farmer, a monthly publication in English and Spanish; the publication and distribution of all bulletins, circulars, pamphlets, and press notices; the supervision of the Bureau of Agriculture library; Bureau photographic, planotype, and mimeograph work and miscellaneous transactions.

STATISTICS SECTION.

Routine Work.—The routine work of the section has been confined to the compilation of the returns contained in the reports submitted by municipal presidents as required by legislation. There are at present in the Philippines 901 municipal presidents of localities who submit four quarterly and two semiannual reports, and 56 governors of provinces and subprovinces who submit 12 monthly reports, each year, making altogether 5,080 reports received by the section with a total of 669,126 replies. The transcription of these replies into tables requires a considerable amount of work and time. Once that these replies are arranged in tables by crops and by animals, local measures are reduced into legal ones and the average yields per hectare, the average prices, and the total values are found.

During the year, there has been a considerable amount of correspondence, between this office and the offices of the municipal and provincial governments, on account of the delay in submitting the reports they were required to make by legislation. The return for correction or further information of reports has involved also an extra work that increased greatly the number of letters handled.

CONSTRUCTION AND REPAIR SECTION.

This section has charge of the upkeep and repair of all Bureau transportation and machinery, repair and manufacture of office furniture and equipment and the construction and repair of buildings belonging to the Bureau of Agriculture. This section received and accomplished 176 serial and work orders and 55 furnish orders for bicycles, 69 repair orders and 76 furnish orders for motorcycles, and 22 repair orders and 11 furnish orders for automobiles during the year. In operation and maintenance for six passenger automobiles and two White trucks during the year, for gasoline, oil, grease or lubricants, and auto accessories, the total expenditures amounted to ₱11,241.87.

AMERICAN COLONIES SECTION.

Of the total of 60 homesteaders in the American colony at Momungan at the establishment of the colony, 33 remained at the close of the year 1917. In accounts current with these colonists the government has advanced to them for various purposes the total sum of ₱96,044.31. Of this they have repaid in all, the sum of ₱45,994.66, leaving a balance due of ₱50,049.65. The total cash funds available for the colony at the close of the year 1917, was ₱19,350.22. The value of colony building is ₱6,319.70, equipment ₱1,627.30, merchandise, ₱11,128.52. The total organization expense for the colony is ₱28,219.22.

The departure of some American colonists has left vacant homesteads, and a decision was made during the past year by the Honorable the Secretary of Agriculture and Natural Resources to admit Filipino colonists to these homesteads on practically the same terms and conditions as were made to the original homesteaders. As a result a few Filipino homesteaders have been admitted to the colony and more would be added if funds were available. The colony can hardly be designated as a prosperous one, yet considering the disadvantages and discouragements incident to any pioneering project, they have done fairly well, and it is hoped that their worst difficulties have been overcome and that those who remain as well as those newly admitted, will prosper in the years to come.

ANIMAL HUSBANDRY DIVISION.

General remarks.—The demand for live stock has been exceedingly large and this demand could only be supplied to a limited extent during the greater part of the year. Owing to the plan of establishing stations in the provinces in connection with the food campaign during the last three months of the year, the sales had to be practically discontinued in order that there should be sufficient breeding stock on hand for these new stations. These stations will in the main be of a temporary character and primarily for the production and distribution of swine and poultry, but might also comprise public breeding of large animals.

During the year one new station was established at Cebu and another will soon be in operation at Iloilo provided funds are available. The breeding station at Virac, Catanduanes, will be discontinued but the work in other localities throughout the Islands will be greatly extended and conducted on a much larger scale if present plans are carried out.

The above plans presupposes the necessity of the importation of live stock in the shortest possible time and regradless of cost. A shipment of Indian cattle from India was received in Manila last April by a local firm. A part of this shipment was for the Bureau of Agriculture. The unsatisfactory conditions on shipboard, as well as the time consumed on the voyage to Manila, resulted in the live stock arriving in very poor condition. However, the demand for them was so great that notwithstanding their condition and the high prices demanded, there was a rush for them by live stock raisers, before and immediately after they were immunized to rinderpest and the quarantine was raised. At the present time there is still a long list of persons who urgently request this kind of cattle.

The results relative to this importation of fowls from the United States, were satisfactory, but the same cannot be said of the Cantonese chickens imported from China, where dealers do not interest themselves as to whether the chickens are good, bad, or indifferent, and send the birds out improperly crated. As a result many fowls are lost by being stolen in transit and

many die while under confinement. At present the animal husbandry divisions has standing orders for poultry and swine from the United States and Australia which it is expected will arrive during the next year. There is a notable shortage of eggs and poultry throughout the Archipelago as evidenced by numerous reports received and also by the great increase of from 40 per cent to 50 per cent in prices in the Manila and provincial markets.

The correspondence of the division has increased greatly over that of previous years, due to the fact that the people are every day becoming aware of the importance of the live-stock industry in connection with food production. Their inquiries have largely been concerning care and management, feeds and feeding, public breeding, and the purchase and sale of poultry, cattle and hogs. But little interest has been shown by farmers in the breeding of horses, sheep, and goats.

A few articles in regard to swine and poultry were prepared by the division and published in the Philippine Farmer, which aroused considerable interest among readers of the paper. Several trips of inspection were made by both the chief and the assistant chief of the division to various stations during the year. There have been many conferences with farmers and prominent officials on subjects pertaining to the work of animal husbandry.

Purchase and sale of animals.—During the past year there were sold by the Bureau, 54 cattle, 3 carabaos, 174 swine, 16 goats, 3 sheep, 400 poultry, bringing in a total revenue of ₱9,872.50. During the same period the live stock purchased consisted of 54 horses and mules, 161 cattle, 95 carabaos, 6 swine, and 61 poultry, at a total cost of ₱30,742.52. For other branches of the Government the Bureau purchased 32 horses, 13 cattle at a cost of ₱7,366.00.

Feeds and feeding.—The increase work of the animal husbandry division has prevented much research work as regards feeds and feeding. The prices of imported feeds is absolutely prohibitive and therefore must be substituted by products of local origin and even these products are at present so high priced as to seriously suggest the need of Government legislation and control. There is a noticeable shortage of feeds for live stock throughout the provinces. The price of corn per liter has increased during the year from about 6 centavos at the beginning of the year, up to 10 and even 12 centavos at the close. Palay tiqui tiqui have likewise advanced materially in price. Copra

meal is coming into more general use. Tests of feeding meal from several factories were made at Alabang during the early part of the year with very satisfactory results. The amount of forage produced at Alabang this year was larger than could be consumed on the farm. We were therefore enabled to supply the Bureau of Prisons with 9,119 kilos, the Philippine Oil Company 30 tons, and an equal amount to the veterinary division. There is still on hand at Alabang a surplus of Japanese forage cane available for other stations. The pastures at La Carlota and Trinidad have been in good condition throughout the year.

Public live-stock breeding.—This project is very popular among the people and is attracting a great deal of their attention. Many applications for bulls, boars, and stallions are being constantly received from private parties and municipalities, which could not possibly be filled this year and unless the number of animals is increased next year the same conditions will prevail.

The policy of requiring municipalities certain requirements before being allowed to have animals for public breeding purposes has greatly ameliorated the death rate and condition of the animals for public use. However, when compared with animals under the charge of Bureau employees they are poor; for the latter not only have the animals in better condition but also have shown and given much better results. This fact proves conclusively that unless they can be placed directly in the hands of Bureau employees it is always best to sell them.

Alabang Stock Farm.—The activities of this farm have been practically the same as in previous years but the farm has progressed very slowly, principally, on account of the reduction of laborers, there being fewer laborers this year than in the past years.

The cattle fences have been repaired the entire year. As the bamboo posts decay they were replaced with new bamboo posts as concrete posts were not available. On three occasions during the third quarter the floods carried away several parts of the fences and this caused a great deal of inconvenience.

For the most part, the general routine was to keep grounds and sides of the roads clean, the trees pruned, and the irrigating ditches kept in proper condition. Portable colony houses, drinking and feed boxes, pig and chicken crates were built. The necessary repairs were made to farm buildings, carts, brooders, incubators, farm implements, machinery and water pipes. The old Spanish bridge was rebuilt during March to

facilitate the work in the farm and inspection. A concrete muffler had to be built for the 50 horse-power oil engine as the one made of brick was not strong enough to withstand the pressure of the exhaust from the engine.

The pumping of the necessary irrigation water, the grinding of corn and mongo for the mixed feed and the cutting of forage cane for the cattle and pigs has been all the work to which the engines were engaged this year.

Trinidad Stock Farm.—Mr. Bert Duckworth, acting superintendent of the Trinidad Stock Farm is the only salaried employee in this project.

The superintendent visits the near-by townships to encourage the natives to breed their animals to the Bureau stallions at the stations. Only five mares were bred to the stallion during the year.

A number of animals were treated for various ailments free of charge. There were also some horses and cattle castrated during the period.

The work has been carried mostly on the reconstruction of the cattle corrals and the building of driveways leading thereto, on fence repair and the changing of wooden posts to cement posts. Range burning received also considerable portion of the time of the station's force which consists in the average of six laborers and one capataz.

A very lamentable accident happened to the superintendent of this station near the end of the third quarter in which he suffered severe injuries in the legs due to a fall from the Bureau rig while on official duty. This necessitated the sending one of the Central Office force as we were already short of field men.

At many times during this year there were plans by some Government officials, not of this Bureau, to transfer this station to some other branch of the Government. It is sincerely believed that such would be very unwise as the retention of this station by the Bureau of Agriculture is very necessary and important for the well being of the Mountain Province, its vicinity, and the country as a whole.

HORSE PROJECT.

Alabang.—The horse project at this station is not important. There are only 2 native mares, one American-Australian stallion, 6 geldings and two colts. All the horses were in good condition at the end of the year.

La Carlota.—In spite of due care attention which were given

our horses, dreadful disease of surra again appeared at this station after its occurrence in 1915. Our Arab stallion, property No. 118, died of the disease. The other horses were found upon blood examination to be entirely free from the animal parasite *Trypanosoma evansi,* the specific cause of surra. If it is possible, a new Arabian stallion will be sent over to take the place of the one which died.

The horses at this station have received and average daily ration of about six pounds of palay or corn per head, in addition to the green forage they could eat. Two horses died during the year and one male colt was dropped on September 12, 1917.

CATTLE PROJECT.

Alabang.—The cattle were in fair condition throughout the year. Of the cattle received during the second quarter, the Multani were put in the old Indian pasture and the Nellore in the large pasture with the others. Many of them were received with sores and bruises and were treated daily until recovery. The young bulls and steers were kept in the pasture near the old laboratory building and have remained in good condition throughout the year. The milch carabaos which arrived at this station on June 17 are in fair condition. Sixty-one calves, 30 males and 31 females, were dropped and 7 died during the year.

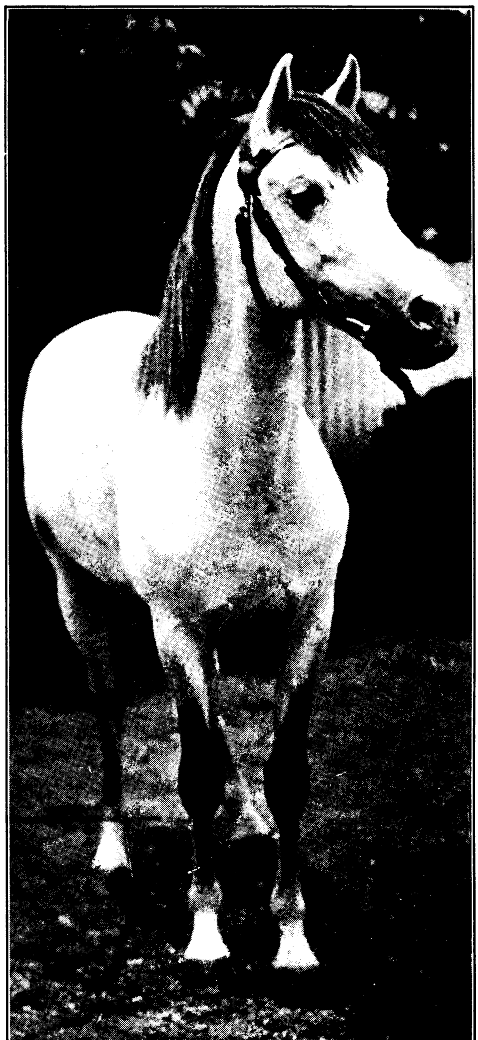
Owing to the heavy rains during July the young cows with their calves had to be caught and placed in a shed with cement floor to protect them from the severe weather. As a result there occurred accidents with two cows which were lamed very badly from slipping on the floor and they died on account of said injury.

La Carlota.—On account of the abundant rainfall during the months of May and June, the grass in Indian cattle pasture has grown quite luxuriantly, there being always green feed for the cattle. The small shrubs which grew all over the field were dug out from time to time, in order to give the edible grasses a better chance to grow. The animals are daily inspected in the pasture, and salt is given them twice a week. Nearly all the herd is at present in fine condition.

Among the Chinese cattle at the beginning of this year there were 4 cows and 10 bullocks, eight of the latter being Indo-Chinese. Two of the cows and one of the Indo-Chinese bullocks were sold at auction on account of old age.

The grade cattle have been pastured daily on the open land and given salt twice a week as usual. As there was abundant

View of a herd of cattle at the Trinidad Stock Farm, Benguet, Mountain Province.



Karrar (Arabian horse) imported from Bombay, India. Used for upgrading native stock.

grass in the pasture even during the entire dry season, the good condition of the animals has been maintained.

Trinidad.—The cattle at this station remained in good condition during the year. They were all free from the usual insect pests.

SWINE PROJECT.

Alabang.—During the first semester the swine made a good showing. The brood sows produced normally and their litters were of the average in number. However, the majority of the suckling pigs died during the second semester, supposed to be due to the old age of their sires and dams, especially of those imported from the states. All boars, sows, and weaned pigs are in perfect condition. To increase the vitality of their future offspring the old boar Prop. No. 93 was replaced with boar Prop. No. 356. It is intended to utilize for the growing pigs next year all available space to give them a larger area in which to pasture and to allow them more exercise. The reason for this is that the yards will be better supplied with green grass and there will be the advantage of less danger from infection with kidney worms. The empty lots can then be plowed and later planted to sorghum, peanuts, or some other legume or plant that is desirable for hogs.

The average number of pigs per litter is seven and the production of males and females has been about even. Four hundred sixteen were dropped and one hundred ninety died during the year.

Trinidad.—On April 10, 1917, six (1 male and 5 females) Berkshire pigs were sent to this station. One female pig out of this shipment died on May 19, 1917. Thirteen (7 males and 6 females) were dropped and six (1 male and 5 females) died during the year.

La Carlota.—At present we have two breeds of swine at this station, consisting of Berkshires and Duroc-Jersey. These animals are being fed twice daily with rice, corn, sweet potatoes, and allowed to run on pastures of guinea grass, peanuts, and sweet potatoes.

Some of the animals which had been suffering from paralysis in the past have been cured. At present we have a couple of animals which are still affected with the same trouble, but these too are showing some improvement as they are being given small doses of nux vomica internally, in addition to the external treatment of camphor or soap liniment applied occasionally on their afflicted parts.

GOAT PROJECT.

Alabang.—The goats at this station have reproduced normally and are present in good condition. Although only few requests have been received during the year when compared with other live stock, still we are unable to supply the demand owing to the small number of goats in the herd. Thirty-two kids were dropped and three died during the year.

La Carlota.—The goats at this station are doing fair but the raising of goats, according to advices, does not appeal to the people in this neighborhood. It is desired to transfer these goats to Alabang as soon as the foot-rot disease is found to be completely eradicated. Twenty-five kids were dropped and three died during the year.

SHEEP PROJECT.

La Carlota.—The sheep are now in fair condition and are gradually increasing, notwithstanding the effect the foot rot had on them during the past years. Nineteen were dropped and one died during the year. Many of the animals that were affected with foot rot in the past rainy season were cured. Much attention is being given to this trouble to prevent any further losses.

POULTRY PROJECT.

At the beginning of the year this project comprised the raising of chickens at Alabang, La Carlota, and Trinidad, but the work was extended near the end of the third quarter to Cebu and Batangas. The results obtained, with the exception of Alabang, were satisfactory. In round numbers the poultry at Alabang increased 20 per cent, at Trinidad 160 per cent, and at La Carlota 560 per cent. But it is believed that there is still room for improvement.

Alabang.—At Alabang the hens laid well with an average of 92 per cent of fertile eggs. The feeding of animal matter had a decided influence in the increase of the fertility and production of eggs and this can be easily explained by comparing the analysis of an egg with that of the substance fed. On the other hand, recent experiments carried in the States have shown that animal protein is more easily assimilated by poultry than vegetable protein and this is responsible for at least the increase in production of eggs. However, there is the danger of overfeeding animal matter which should be avoided as the poor results at Alabang in raising chickens is supposed to be partly due to overfeeding of animal matter.

The incubators with the exception of the Petaluma have given satisfactory hatches. The bad results obtained from the latter

were very likely due to improper management. For the reason that the hot-water incubators gave better results than the hot-air incubators it was deemed proper to increase the number of hot-water incubators.

According to reports, very poor results were obtained from the fireless brooders and their use was entirely stopped this year. Proper management is believed will give the desired results and it has been decided to give them another trial next year. Slightly better results were given by the hot-water brooders, but they can not be classed with the mother hen, the chicks of which made a good growth in the second quarter considering the bad weather which then prevailed.

The mortality of chicks and adult chickens increased materially the second semester and the cause of it was attributed mostly to chicken pox and roup.

The regular moulting season seems to begin during the end of July with Cantonese and August with the American birds. This was very noticeable as the good production of eggs begins to decrease during that time. The fertility of eggs was also slightly affected during this period.

The Indian Runner Ducks which arrived last April have done wonderfully well, considering the conditions to which they were subjected while in route from California to Manila. They began to lay three days after their arrival and the change of climate has not altered their good name as good layers.

This duck, as its name implies, originated in India. From there it was taken to England and later to the United States in which countries the strain was improved to its present state. This duck is noted for its laying qualities and it is expected that it will, in years to come, be popular as a table duck. The drake weighs about 4½ pounds and the duck a trifle less. They are fawn, gray, or white in color but the former is the most popular variety and is what the Bureau has at Alabang. They are non-sitters, very much like the "Taguig" ducks in conformation, very hardy, first-class foragers and are quite domesticated. To produce fertile eggs it is claimed that it is necessary to supply the bird with swimming water and we might add that the water should be kept as fresh and clean as possible.

This year the sales of eggs amounted to ₱1,981.19. There was an increase of about 10 per cent in the average production of eggs per individual hen.

La Carlota.—The results obtained from poultry at this station have been very satisfactory and beyond expectations. However, as a center for the distribution of poultry, it has not met the

approval of many officials for the reason that it is not centrally located.

Trap nests are being used for the hens, so that we have a complete record of the number of eggs laid by each individual hen of each breed at this station.

Our grown chickens are being given a grain ration of palay and corn, and in addition, fish and shells are also given from time to time; the young chicks are fed on a ration of part hard-boiled eggs, milk, and ground corn or rice middlings.

Trinidad.—The Black Minorca chicken has been found to be more delicate than the White Leghorn. At both La Carlota and Alabang, the results were very unsatisfactory, compared with those at this station and the adaptation of this chicken in this country will have to be presumably done by first introducing them in this region where it seems to be better adapted than in regions of a lower level, and then gradually distribute them to other provinces. The only logical reason for this adaptation is the climate, which is local.

RÉSUMÉ OF THE WORK OF THE VETERINARY DIVISION FOR THE YEAR 1917.

By Dr. STANTON YOUNGBERG, *Chief Veterinarian.*

The greater portion of the activities of the veterinary division during the year 1917 were devoted to the control of a severe outbreak of rinderpest. At the Veterinary Research Laboratory a great deal of work has been accomplished with the virus of rinderpest and also in the working out of a new method of immunizing against this disease.

PERSONNEL.

On December 31, 1916, there were on the rolls 18 veterinarians (of whom 8 were Filipinos and 10 Americans), 24 American live-stock inspectors (including 5 without salary), 375 Filipino live-stock inspectors, 1 American clerk, 2 Filipino clerks, and 1 American foreman.

On December 31, 1917, the force consisted of 24 veterinarians (of whom 15 were Filipino and 9 Americans), 15 American live-stock inspectors (including 6 without salary), 346 Filipino inspectors, 1 American clerk, and 3 Filipino clerks. This constitutes an increase of 7 Filipino veterinarians and 1 Filipino clerk and decreases of 1 American veterinarian, 9 American live-stock inspectors, 29 Filipino inspectors, and 1 foreman (American).

ADMINISTRATION.

Importation from foreign ports.—During the year a very few cattle were received from Spain and Australia for dairy or breeding purposes and nearly 500 cattle of Indian breed were admitted via Singapore.

Small numbers of cattle and carabaos were imported for slaughter or work purposes from Pnom-penh, Saigon, Honkong, and Singapore.

Inter-Island shipments.—During the year 20,194 cattle and 3,007 carabaos arrived at Manila from inter-island ports. This is an increase of over 5,000 cattle from the 1916 figure which in turn were far above those of any previous year.

Inspections for which fees were charged.—During the year 142,545 animals of all kinds were inspected on arrival at the city of Manila, for which fees amounting to ₱18,658.20 were charged and collected. Of these animals 110,760 were swine.

Post-mortem inspections in Manila matadero.—There were 125,716 animals of all kinds inspected at the Manila matadero during the year, 1,400 being condemned, and 124,307 passed for food.

COMBATING OF ANIMAL DISEASES.

Rinderpest.—The severe outbreak of this disease, which assumed such serious propositions in 1916, continued with unabated virulence throughout the current year. The recorded number of cases and deaths, 33,971 and 26,951 respectively, are in fact considerably in excess of the 23,808 cases and 18,251 deaths reported in 1916. As was stated in the last preceding annual report, these figures represent only such cases and deaths as were discovered by members of the veterinary force or voluntarily reported by owners or local officials. This being the case, the apparent increase of rinderpest cases and deaths in 1917 may perhaps be due to more complete returns rather than to an increase in the actual losses.

It was apparent from the beginning of the year that the appropriation for the veterinary division was entirely insufficient to even enable us to carry the force through the year to say nothing of the increases that might become necessary from time to time to control new outbreaks. On May 11, 1917, the Emergency Board made an allotment of ₱250,000 in addition to the ₱140,000 appropriated by Act No. 2672 for the rinderpest campaign. This has enabled us to continue in the service the personnel on hand at the beginning of the year and to make such increase from time to time as the situation required.

The following table shows the incidence of rinderpest cases and deaths during 1917 by three-month periods:

Rinderpest cases and deaths by quarters.

	New cases.	Deaths.
First quarter	8,245	6,325
Second quarter	9,376	7,762
Third quarter	9,198	7,573
Fourth quarter	7,152	5,291
Total	33,971	26,951

The year opened with 18 provinces and 87 municipalities infected; and ended with 23 provinces and 115 municipalities

infected. The total number of provinces infected during the year was 30, or 7 more than during 1916.

These provinces that became newly infected during the year accounted for 14,466 of the new cases and 11,585 of the deaths. Some of these provinces such as Mindoro, Department of Mindanao and Sulu, Leyte, Sorsogon, and Samar had not been infected with rinderpest for several years. During those free years there had been born thousands of animals which were more or less highly susceptible and which would naturally more readily fall prey to the disease than older animals which had required more or less immunity during previous attacks. Other provinces such as Laguna, Oriental Negros, and Nueva Vizcaya had had rinderpest during more recent years but in a comparatively mild form and therefore had many susceptible animals that would quickly fall victims to an outbreak as virulent as that of the past year.

It has not always been possible to trace the source of these new infections. This can be readily understood when one takes into consideration the fact that not only carabaos and cattle, but also swine, sheep, and goats are susceptible to rinderpest and that these latter animals often have the disease in a mild, obscure form. In the southern islands communication between the various islands is by means of small sailing vessels, which frequently have a few pigs or goats aboard. As they can land at any place along the coasts it can be seen that they might scatter the infection in a manner which would be almost impossible to trace.

The Department of Mindanao and Sulu was free from rinderpest at the end of the year. The veterinarian of the Bureau of Agriculture detailed there was given a free hand by the local authorities and received not only their fullest coöperation but also that of the Constabulary which was detailed to assist him. As a result the province was completely cleaned in a few months time. At the present writing it appears that the disease is gradually being brought under control in the other newly infected provinces and also those that were infected at the beginning of the year. The prospects are therefore brighter of making a considerable reduction of the area infected and also of the cases and deaths during the coming year.

During the past year considerable quantities of antirinderpest serum have been used in the various infected provinces; Bulacan, Rizal, Laguna, Cavite, and Pangasinan having been the largest consumers. The most insistent demand came from those provinces and municipalities which had recently become infected

and where the disease was causing a heavy mortality. These were the places where the greatest results were expected from serum and where in reality the least satisfactory ones were obtained. This can be accounted for by the fact that as there had been no severe outbreaks of rinderpest in many of these places for several years a considerable number of susceptible animals had been produced in the meantime; also the disease during the present outbreak was of a very virulent type. Also, another factor was that after the animals had been injected with serum there was a tendency toward laxness as far as quarantines and isolation were concerned. The majority of people unfortunately expected too much from the serum; many were of the opinion that the immunity conferred would last as long as a year and in nearly all places the opinion was prevalent that serum conferred an immunity lasting from two to six months. As a matter of fact experience has shown that serum cannot be depended upon to confer an immunity for a much longer period than 10 days. Antirinderpest serum when injected into an animal produces no reaction and its action is maintained only up to time that the antibodies have been eliminated by the natural body processes, after which the animal is again susceptible to infection. In many individuals this elimination is very rapid as we have records of many animals which came down with rinderpest within a week after the injection of serum. Many authorities claim that antirinderpest serum does not prevent infection with rinderpest. Holmes, in India, has expressed the following opinion, "It appears to me that the infection can be taken into the system immediately after the serum injection, and that it produces its reaction at the time when the immunity is decreasing." Stickman, in the Transvaal, came to the following conclusions, "That serum alone can not be depended upon to give absolute immunity for a much longer period than 10 days, therefore the injection must be repeated three times with that interval to protect an animal for a month (the outside limit of infection). To insure success, the serum must be injected to all the cattle likely to come in contact with the infected; it will, of course, save serum if the infected herd can be properly isolated from its neighbors." In the report of the proceedings of the Eighth International Veterinary Congress the following statement is made in regard to Professor Arloing's experience in Egypt. "Professor Arloing could not acquire in Egypt, a conviction upon the practical value of serum. Certain results seem to indicate that this serum but prolongs the incubation period; in other case it prolongs the duration of the

infection. In a large estate there were 45 deaths after 4 injections of serum."

Ward, in his "Experiments on the Efficiency of Anti-rinderpest Serum" states, "That antirinderpest serum does not prevent infection with rinderpest. On the contrary, animals infected with serum and exposed to rinderpest soon contract the disease and pass through a more or less modified attack." Our experiences coincide with that of the authorities quoted above. Therefore it is well not to expect astounding results from the use of serum, and especially so when administered in districts where the rinderpest is of a high virulence. The method employed in India of mixing the animals which have been given serum with the sick ones to induce a mild infection could not be generally employed in the Philippine Islands. The reason is that the cattle and carabaos of this country are more highly susceptible than those of India and therefore disastrous results might follow this procedure. It is possible that fairly good results might be obtained with this method in the Ilocos provinces where the *present* rinderpest infection is very mild, but it would be out of the question to attempt it in places where we have rinderpest of a greater virulence.

The sum of ₱50,000 out of the ₱250,000 allotted by the Emergency Board was set aside for the purchase of serum and the sale or distribution of this in such manner as the Bureau of Agriculture might deem advisable. Serum to the amount of ₱5,990.88 has been distributed free of charge. Of this amount ₱1,297.90 is for serum injection free of charge to sick animals to test the efficiency of the serum as a cure; the remainder was injected free of charge among the animals of people who claim that they were too poor to afford the cost of the serum. In this connection it might be stated that the testing of the efficiency of serum as a cure coincided with the results previously obtained by several workers, namely that serum has no curative value for infected animals. Considerable quantities of serum have been injected at half price.

The continuance of the free distribution of serum or its sale at half price is not recommended for the reason that the results obtained from serum are not commensurate with the expenditures involved. The immunity conferred is too short to be of any real value in the eradication of the disease. On the whole it is safe to say that the people in the provinces who have had experience with antirinderpest serum do not now have the same faith in its efficacy which they possessed a year ago.

Immunization.—On March 9, 1917, the Philippine Legislature

enacted Act No. 2679 appropriating the sum of ₱250,000 to carry out the provisions of Act No. 2548 "for the immunization of cattle and carabaos to prevent the spread of rinderpest in the Philippine Islands." The funds appropriated by this Act provided for the salaries and traveling expenses of the technical personnel, acquisition of instruments and medicines required, purchase of animals for virulent blood, and for aid to the "insurance fund" of provinces in which immunizing stations are established.

Most of the immunizing operations during the year were carried on in the province of Pampanga. This was due to the fact that the immunization of cattle and carabaos was begun in that province in 1914 and had been steadily continued through the year 1915 and 1916. The stations were already established, the personnel trained, and the people accustomed to the work. The Governor of this province has also taken a very active interest and devoted a great deal of his time to popularizing and extending the work of immunization. The immunizing stations at San Fernando (with a substation as Santa Rita) and Macabebe (with a substation at Apalit) were ín operation at the beginning of the year. Work was commenced at Lubao in July and at Angeles in September. The San Fernando and Macabebe stations were temporarily closed in June as the people had to use their animals during the rice planting season; they were however, reopened in September. During the months of November and December none of the stations could be run at full capacity owing to the rice harvest and the beginning of the sugar milling season.

At Iloilo the total number immunized was 1,280 of which 947 were carabaos imported from Indo-China and 333 native animals. At the Pandacan Quarantine Station there were immunized 1,263 carabaos and cattle, 8 sheep and 2 goats. Only 300 of these were native animals the rest being carabaos imported from Cambodge and cattle from India and Hongkong.

The total number of animals immunized at different stations during the year was, therefore, 7,191 and the total number of deaths occurring from all causes from the time of entrance until the release of the animals was 274 or 3.8 per cent of the number admitted to the stations. Several of the deaths occurred from such causes as colic, tetanus, abortion, paralysis, and injuries accidentally received. But the most difficult problem was presented by the animals that were already in the period of incubation of rinderpest, though apparently normal at the time of

Immunizing Station, San Fernando, Pampanga.

Partial view of laboratory (on right) cattle sheds (on left) and dipping tank in foreground.

arrival at the station, and one, two, or three days afterwards came down with the disease. It was possible to save but a small percentage of these animals. At the present time we know of no good practical way of absolutely eliminating this factor. As yet no test has been discovered which will show whether an apparently healthy animal is already infected with rinderpest. We have tried keeping the animals under observation for some days before submitting them to the simultaneous inoculation. The people do not like this very well, however, as they consider the three weeks period required for immunization a sufficiently heavy burden. Until some reliable test may be discovered it will therefore be necessary to rely on the skill and judgment of the veterinarians in charge of the various stations, always bearing in mind that cases of this kind are bound to occur in spite of their most careful and painstaking inspections.

Of the imported animals received during the year at the Iloilo and Pandacan stations nearly every shipment has on arrival been found to be infected with rinderpest. This accounted for the majority of the deaths in these shipments. Four different lots of cattle, totalling 195 head, imported from Hongkong were upon arrival found to be badly infected, as a result of which 30 head succumbed. Considering the fact that each lot had several animals that showed very typical symptoms of rinderpest on arrival, it is strange that no evidence of disease were noted at the time of embarkation as the steamer run between Hongkong and Manila is only about 60 hours. We have no control of the inspection at the ports of embarkation. The importers bear all the losses and it should therefore be part of their business to use all possible precautions to obtain clean shipments of animals. One shipment of cattle from India came down with foot-and-mouth disease three days after arrival; two different shipments of carabaos from Cambodge (Indo-China) were also found upon arrival to be infected with this disease. Animals become greatly debilitated from this disease, and it was therefore necessary to hold these shipments for several weeks before subjecting them to immunization against rinderpest. When such animals then do react to the inoculation they very frequently pass through a pretty severe course of the disease. These facts show that clean shipments of imported animals are the exception rather than the rule, and it has therefore not been possible to admit them to the "immunization insurance" provided by Act No. 2548.

During the past four years 30,131 carabaos and cattle have been immunized against rinderpest by the Bureau of Agriculture.

These animals live in rinderpest infected districts, are not subjected to quarantine regulations and have had an ample opportunity to contract the disease. To the best of our knowledge less than 1 per cent of the these animals have subsequently contracted rinderpest. Owners of immunized animals are very quick to report any ailments with which they may suffer. Several times our veterinarians have been called upon the pretext of rinderpest and have found some minor ailments and frequently nothing noticeably wrong.

Experience seems to indicate that immunized suckling calves lose their immunity after a year or thereabouts. If true, this is not a very serious defect, as these animals can easily be returned for immunization at the end of this period and still not cause the owner much inconvenience as even then they would not be old enough to work. Further experiments are being conducted to test the immunity conferred upon suckling calves by simultaneous inoculation. These will be reported upon in detail when more definite conclusions have been arrived at.

Experiments are also being conducted to determine the duration of the immunity in animals which showed no reaction after the simultaneous inoculation. A detailed report will be made upon the conclusion of the experiments.

The rapid extension of the immunizing campaign has been greatly delayed by the shortage of our veterinary personnel. Owing to the severity of the rinderpest outbreak it was necessary to keep the majority of our force on quarantine work, and even then we were not able to supply more than about half the number of veterinarians that various provinces and municipalities requested be sent to assist them.

Recommendations.—Immunization properly applied is the surest method for the control of rinderpest, and with judicious extension will be one of the prime factors in the eradication of rinderpest in a short time and without the necessity of observing the fundamental principles of sanitation and hygiene. All the measures at our disposal must be properly and carefully applied in order to keep the disease well under control and thus give hope of ultimate success in its eradication.

Rinderpest is enzootic in many sections of the Islands and it will take time, perseverance, and patience to stamp the disease out in these centers. This means that the people will also have to learn that they will have to spend some money for the protection of their animals and not depend upon the Government to pay for everything. In this country even those people who can well afford it are disinclined to spend any money for

the services of a professional man to treat their animals. Such things as the free distribution of serum do not tend to remedy this matter.

Foot-and-mouth disease.—On March 2, 1917, a shipment of 354 Indian cattle, 8 sheep, and 2 goats arrived in Manila from Singapore. These animals had been purchased in India and sent to Singapore in small lots and were held at that place until the total number had arrived and a steamer chartered to convey them to Manila. Some of these cattle had been in Singapore for 3 months. They were embarked February 25 and were five days en route to Manila. Inspection on board ship upon arrival revealed no sign of disease. They were however taken to the Pandacan Quarantine Station for detention and observation prior to immunization against rinderpest. On March 5 some of the animals presented clinical evidence of foot-and-mouth disease and within 18 days the entire herd was infected, and the majority passed through a severe attack of the disease. It is evident that the shipment had become infected immediately prior to embarkation at Singapore as the disease did not become clearly evident until 8 days after that time. It was not feasible to order the slaughter of these cattle as they were valuable animals imported for breeding purposes; they were however, put into the strictest isolation and all possible precautions taken to prevent the escape of the infection from the quarantine station. But as was feared from the beginning this proved to be an impossible task. There were at the time over 1,000 head of cattle within the quarantine station, beside the shipment in question there being about 600 Indo-Chinese cattle and 100 native cattle on hand. Within two weeks after the appearance of the foot-and-mouth disease practically all the animals in the station were infected. Feed had to be brought for all the animals and left near the limits of the station and it was therefore impossible to keep the place absolutely isolated. In some manner the infection did escape as the disease was discovered in some carabaos in the city of Manila the first week in April. The virus had become greatly attenuated, however, as the disease in Manila did not run a severe course and among carabaos was especially mild. Neither did it spread any further than to the adjoining towns of Rizal Province. Infected and exposed animals were carefully isolated and regular and careful inspections carried on in the infected and suspected areas. By the middle of September the disease in Manila and vicinity had been brought under control.

In some inexplicable manner the foot-and-mouth disease was carried to San Jose, Mindoro, making its appearance there the first part of September. It has been confined to San Jose and immediate vicinity and according to the reports received from our veterinarians had practically been brought under control by the end of the year. No other provinces become infected during the year.

Two shipments of carabaos from Saigon also arrived infected with foot-and-mouth disease; one shipment of 68 head on October 23, 1917, and another of 71 head on November 11, 1917. As these shipments were small they were more easily handled and placed in strict isolation, and therefore did not cause any further spread of the infection.

Surra.—No special campaign against this disease has been undertaken the year owing to the heavy demands made by the rinderpest campaign upon the personnel of the division and the absence of any known preventive or curative for this disease. Surra is known to be widely disseminated in the Islands and numerous reports of the loss of animals from this cause have reached this office.

Glanders.—Cases of glanders among horses have been found from time to time during the year in the city of Manila and ordered destroyed. In this connection, it should be noted that the destruction of the infected horses, is frequently bitterly opposed by the owners.

Hog cholera.—This disease is known to exist in all the swine raising regions of the Archipelago and undoubtedly causes serious losses each year. No reliable statistics have been obtained as to number of cases and deaths. The custom of allowing hogs to run at large and forage for themselves is the very thing that keeps the disease continually alive and, as with rinderpest, greatly increases the difficulties of bringing it under control.

Anthrax.—Cases of this disease have occurred during the year in northern Mindanao and around the shores of Laguna de Bay, but the known losses have not been sufficiently serious to warrant withdrawing men from the rinderpest campaign to combat them.

Hemorrhagic septicæmia.—No cases of this disease have been brought to our knowledge during the year, which is not surprising as the regions where this disease is most liable to cause trouble have been relatively free from rinderpest and hence less closely under our observation.

Immunizing Station, San Fernando, Pampanga.

Partial view of laboratory (on right) cattle sheds (on left) and dipping tank in foreground.

LIVE STOCK IMPORTATIONS.

The year witnessed a further decline in the importation of live stock from foreign ports, due rather to the scarcity of tonnage and excessive freight rates than to any lack of demand in the local market. The shortage of imported animals for slaughter and of the importation of chilled and frozen meat, as well, accounts for the marked increase, noted elsewhere, of native cattle and swine shipped to Manila for slaughter.

During 1917 of the 4,618 cattle arriving at Manila from foreign ports 3,812 were from Pnom-Penh, 497 from Singapore, 195 from Hongkong, 100 from Saigon, 11 from Australia, and 3 from Spain. During the year 185 carabaos arrived from Pnom-Penh, 57 from Singapore, and 71 from Saigon. No changes were made during the year in the general orders regulating the importation of animals.

ILOILO QUARANTINE STATION.

Three lines of work were conducted at this station during the year: Quarantine and immunization of work animals arriving from French Indo-China, immunization of local animals, and the slaughter of Indo-Chinese cattle for local consumption. During the year 220 cattle and 498 carabaos arrived from Pnom-Penh. During the first quarter of the year 104 cattle were slaughtered for food.

VETERINARY RESEARCH LABORATORY.

Mention was made in the Annual Report for 1916 of a new pneumonia discovered in swine. During the past year additional work has been done with this disease. It has been found that its causative agent is a "pseudomonas." The symptoms are quite similar to the chronic form of swine plague and the lesions are also very similar to this disease. The organism is easily cultivated on artificial media; and is also pathogenic to rabbits and Guinea pigs, causing a severe septicæmia when injected subcutaneously, the animals succumbing in from two to three days. A method for immunizing against this disease is being worked out and so far favorable results have been obtained. A detailed report will be made when more conclusive results have been obtained.

A disease in cattle in the Philippine Islands similar to *Anaplasma marginale* has been found and a full report published in the Philippine Agricultural Review, Vol. X, second quarter,

1917. But this disease does not appear to be the cause of any considerable loss among cattle in the field.

In the Philippine Agricultural Review, Vol. X, third quarter, 1917, an article was published on "Experiments on the Treatment of Rinderpest with Various Drugs." Owing to the fact that frequently, people come to this Bureau with the statement that they have cures for rinderpest, it was decided to perform a series of tests with several drugs and publish the results. During the past year we have allowed three different men to try out their cures at the laboratory, and in each case their remedies proved worthless in curing the disease. These men were allowed to administer the remedies themselves and were given entire charge of the animals undergoing treatment. Two men were given three animals apiece and one was given two animals. In every case the animals died of rinderpest and upon autopsy presented typical lesions of this disease. Two of these men left the laboratory fully convinced that they did not have a cure for rinderpest; one man made the statement that he could cure rinderpest in the field but not in the laboratory. The question naturally arises as to whether he was treating rinderpest while in the field or merely some slight digestive disorders. Another point which has to be considered is the fact that men who profess to have cures for rinderpest ordinarily try them out in localities where the disease is present in rather mild form and where the normal recovery is from 50 to 70 per cent. Therefore it is easy to see that if they are at all shrewd, they can eliminate the fatal cases and in this way obtain a high percentage of cures, providing the material they use is administered in small enough doses and is not too injurious to the animal.

The drugs used in the experiments performed at the laboratory were as follows: (1) Eosin; (2) medicinal methylene blue; (3) cocodylate of soda; (4) atoxyl; (5) quinine sulphate; (6) camphorated oil; (7) creolin; (8) permanganate of potash; (9) ergot; (10) iodine; (11) potassium iodide; (12) gentian violet; (13) arecolin hydrobromide; (14) nuclein; (15) formalin; (16) chlorazene; (17) castor oil; (18) alcohol; (19) fluid extract of nux vomica; (20) fluid extract of gentian; (21) gannabis indica. None of these drugs presented any curative value for rinderpest.

A considerable amount of work has been done in locating the various seats of rinderpest virus in the animal body. It has been found that the liver, spleen, lymph glands, intestinal

tract and heart muscle are highly virulent. Extracts made from these tissues can be used for virulent material in immunization and hyper-immunization. These experiments have been reported on in the Philippine Agricultural Review, Vol. X, fourth quarter, 1917.

Work is being conducted upon a new method of immunizing against rinderpest, which up to the present has been giving very favorable results. By this new method the animals pass through the immunization without developing any symptoms or ill effects from the disease, and are rendered highly immune to subsequent exposures to sick animals and injections of virulent material. A full detailed account of this method will appear when it has been perfected to such an extent that it can be made public.

DEMONSTRATION AND EXTENSION DIVISION.

AGRICULTURAL DEMONSTRATION SECTION.

The activities of this section were greatly extended during the year, partly due to the establishment of provincial as well as municipal nurseries in accordance with sections Nos. 1758 and 1759 of the Administrative Code, the tobacco production campaign, the food production campaign, and later on the rice seed selection campaign. For the purpose of helping provincial officials in the food production campaign, one assistant agricultural inspector was assigned in almost every Christian province in the Islands.

The employees of the demonstration and extension section are the field agents of the Bureau of Agriculture. They gather, disseminate, and distribute material information beneficial to the farmers, make actual demonstrations of better agricultural methods and modern implements through coöperators and demonstration stations. They introduce new plants and seeds that are of economic importance for distribution to the farmers. They also supervise the placing and maintaining of breeding animals for public use.

Food production campaign.—Although this campaign has been a part of the work of the field employees since the beginning of the demonstration work in the provinces, yet the campaign of last year was more extensive and the result more encouraging than any in the past. The number of vegetable gardens planted under the direction of the field employees was a great deal larger than ever before. Provincial as well as municipal gardens were established on public grounds in many of the provinces, partly for the production of vegetable seedlings for distribution and partly for the demonstration of the proper methods of growing vegetables.

Rice improvement campaign.—This campaign was carried on along two distinct lines, that is, introducing Bureau improved seed, and selecting local varieties for seed purposes. The selection of rice seed constituted the major part of the work undertaken during the year. This line of the work was greatly emphasized, especially when the Department of Agriculture and Natural Resources inaugurated a more extensive campaign by

employing foremen and laborers for the rice producing provinces. The selection of rice seeds was a success, especially in provinces where cheap labor enabled the farmers to coöperate heartily with the inspectors in the seed selection.

Tobacco production campaign.—This campaign was carried along in connection with the work of the field employees, but the passage of Act No. 2692 enabled the demonstration section to appoint eighteen tobacco inspectors to help carry on the work started by the assistant agricultural inspectors. The increased planting of tobacco this year in the Ilocos Provinces and in Pangasinan can be accounted for partly by the good price paid for tobacco last year but mostly by the campaign inaugurated by field agents of this section.

Public breeding work.—This work properly belongs to the animal husbandry division, but a certain phase of the work has been handled by the field inspectors of the demonstration section. The placing and maintaining of the breeding animals, such as boars, bulls, and stallions were left to the discretion of the inspectors. In fact, when an animal for public breeding was placed in the charge of an inspector, he was held responsible for the care and success of the same. Cebu, Ilocos Sur, Ilocos Norte, La Union, Pangasinan, Pampanga, Bulacan, and Iloilo have made the greatest progress in animal breeding as supervised by this section. During the year 1917, there were 50 boars stationed in the above-mentioned provinces in charge of the field employees of this section, for breeding purposes. Two of these boars died. The other stock for breeding consisted of five stallions, two bulls, and one billy. The breeding work has progressed satisfactorily and a great demand for breeding animals has been aroused among the farmers.

Cebú Demonstration Project.—The prevailing weather conditions during the year have been unfavorable. There was too much rainfall with the result that corn planted in low lying districts was badly damaged.

The tabacco crop was fairly good as a whole. Fine tobacco was raised in the plots in Minglanilla and Argao. Selected seeds from Isabela were used in all cases. The superior quality of the leaves produced over that of the local variety has caused a great demand for seeds.

One plot of Hawaiian sugar cane was harvested during the first quarter and the points available were brought for distribution to new coöperators. There were altogether nine plots of sugar cane planted in Minglanilla, Talisay, Mandaue, Consola-

cion, Danao, Lugo, Bago, and Mambaling. All the plots were planted to Louisiana striped, save in Mambaling where the native variety was used. The sugar-cane plots have grown very poorly and some were entirely a failure. The ratoon crop at Talisay was fair. The sugar-cane crop, as a whole, was poor, excepting where planted in well-drained land.

The prevailing high price of maguey has served as a stimulus for the farmers. Maguey was planted in all sections at the hill sides and near the seashores. In some cases, lands which were formely planted to sugar cane or corn, were planted to maguey. Ten thousand sisal bulbils were also planted.

The most salient feature of the work in this district was the progress made in public breeding. At the close of the year there were sixteen boars and two stallions stationed in this district. This work has progressed very rapidly since an assistant has been placed to look after it. Not less than 361 mestizo pigs were raised during the year.

Tabonoc Demonstration Station.—The province of Cebu appropiated ₱2,000 for the establishment and maintenance of this station. The work was started last May. In this station, there were planted vegetables on a large scale, mango seeds, chico, kapok, mabolo, nanca, papaya, and santol, and 5,000 coconuts to be planted along the provincial road. The five plots of corn planted last May have made a fair showing and farmers were surprised to find some corn producing from two to three well-developed ears to the stalk. Rice plots were also planted at the station, giving fair results.

Iloilo and Capiz Demonstration Project.—The weather conditions throughout the year were exceedingly unfavorable. Plots that were planted to corn had to be replanted several times, while others had to be abandoned. The weather was favorable, however, for the planting of more rice than in any previous year.

There were altogether fifteen corn plots handled throughout the district during the year. The corn crop all over the district was a poor one, as a whole.

Twenty rice coöperators in Capiz and Iloilo, of the Apostol, Conner, Cruz, Inantipolo, and Roxas rice varieties, were handled. The results of these plots were not reported at the end of the year.

During the last quarter, the efforts of the personnel of this project were concentrated on the selection of rice seed. In the province of Capiz along, there were 2,646 gantas of rice select-

ed, while in Iloilo 20,408 gantas were selected for 1,082 owners. Great interest in this work was shown by both the municipal officials and farmers, especially in the province of Iloilo. In many cases, councilors and lieutenants of barrios, at their own request, were given instructions to fit them for instructors, and, where the area to be covered by one foreman was large, these men personally supervised the work without remuneration. There was no record kept of the amount of seed selected under the supervision of these public spirited men. The rice crop in the district was a great deal better than in any previous year. Many farmers, encouraged by the favorable weather and suggestion of the inspectors, planted a second crop of rice, for the first time, right after the first crop was harvested. The rice planted looked promising at end of the year.

The prevailing wet weather in Capiz was taken advantage of by the farmers in planting coconuts and hemp, and by attending lectures on food campaign, poultry raising, stock raising, and selection of seeds.

The breeding work in this project progressed satisfactorily. There were 6 boars, one Nellore bull, one stallion, and one Spanish goat stationed in this district for breeding purposes.

Iloilo Demonstration Station.—During the first quarter of the year, there were planted at the station $\frac{1}{4}$ hectare of guinea grass, $1\frac{1}{2}$ hectares of velvet bean, $\frac{1}{5}$ hectare of peanuts, $\frac{2}{5}$ hectare of cowpea, a plot of Isabela tobacco, and about 15,000 kapok seeds. The corn plot planted during the preceding quarter was harvested. There were 4,000 selected ears of corn for seed purposes and about 2,500 ears of feed corn. Another crop of corn was harvested during the third quarter producing an average of 30 cavans per hectare. Corn planted during the latter part of the year was damaged by excessive rain.

Batangas Demonstration Project.—As a whole, the general field crops of Batangas suffered from drought and strong winds during March, April, August, October, November, and December. The municipalities that have suffered most were Bolbok, Batangas, Loboo, Bauan, Taal, Lemery, Alaca, Balayan, Tuy, Lian, Nasugbu, and Calatagan.

During the year, there were 54 coöperators in 14 municipalities for Moro corn. The results of these plots, due to climatic causes, were discouraging, except in two plots, one in Lipa and another in Rosario which gave an average of 60 cavans per hectare. The corn crop, as a whole, in the province was very poor.

Six coöperators of Bureau rice, such as Inantipolo, Apostol, and Cruz were also handled, but the results, due to drought and strong winds, were discouraging. The rice crop in the district was as a whole, better than the preceding year.

The selection of rice seed, which was on of the important works carried out during the year, has given satisfactory results. Both upland and lowland varieties of rice were dealt with. The inspectors of the Bureau of Agriculture and the laborers paid by the Department of Agriculture and Natural Resources were given a hearty coöperation by the farmers. There were two methods adopted in the disposition of the seed selected by laborers paid by the Government, one was by giving the whole amount of seed selected to the owner for future planting and the other by getting one-fourth share of the seed selected. The amount of seed selected in both methods was considerable. The farmers, who were helped in the selection of seed will become rice coöperators this year.

Batangas Municipal Nursery.—This was established on May 26, 1917, with an appropriation of ₱680. From this nursery 11,350 vegetable seedlings and 2,000 assorted fruit trees, including coffee, were distributed since its establishment. Great interest was shown by the municipal officials and a bigger appropriation for the year following was contemplated.

Lipa Demonstration Station.—The whole farm force of the station has been busily engaged in putting every bit of ground under cultivation. During the year different farm crops, such as rice, corn, camote, gabe, potato, ginger, papaya, banana, and other vegetables were planted. Rice, corn, and forage plants suffered much from drought.

The coffee work was the most important carried at the station in order to revive the coffee industry of Lipa. During the middle of the year, there were at the nursery 19,400 seedlings, 9,900 of which were sold during the year and the rest to be disposed of during the following rainy season.

A model orchard was also planted with 367 Excelsa and Liberian coffee seedlings. The trees were spaced 4 meters apart temporarily shaded with native tañgan-tañgans, which, by the way, made a good demonstration by itself. Anae were planted for permanent shade.

The Bureau of Agriculture furnished the Lipa farmers 12,092 coffee trees, free of charge.

Antique Demonstration station Project.—The weather condition in this project was favorable for rice. The stand of rice

of both the upland and lowland varieties was so large that there were not enough laborers to harvest the crop at the proper time and it was estimated that there was a loss of from 10 to 15 per cent of the total crop. A great deal more rice was produced than formerly.

Several rice coöperative plots were secured, varying in area from 1 to 4 hectares. Apostol, Cruz, and Inantipolo were varieties used. The lowland rice coöperative plots did not show satisfactory results, owing to the fact that the planting was too late. The coöperators were satisfied with the crop obtained and seeds were selected from the plots for future planting.

The selection of rice seed of the local varieties was also carried among the farmers. In San José and Sibalom, there were 250 gantas so selected and the owners will become rice coöperators next season. The selection of local seed among the farmers was a difficult task on account of the mixed varieties that were planted.

Lectures were delivered whenever there was a gathering and the subjects discussed were rice and corn culture, seed selection, vegetable home garden, the improvement of poor soil, the planting of bananas and other fruit trees, and the improvement of live stock. It was estimated that there were more than 2,000 people that attended these lectures.

The Demonstration Station of San José.—About 3 hectares of the station were planted to Apostol and Cruz varieties of rice. This area produced about 100 cavanes. The average yield previously was 15 cavanes per hectare. The land was rather poor and had to be planted with cowpeas and other leguminous plants to improve its quality. All of the rice seed produced will be sold only for seed purposes.

Moro corn was also planted at the station, but gave poor results on account of caterpillars and strong winds. Other crops planted at the station were sweet potatoes, lyon beans, and cowpeas for distribution among the farmers.

Mountain Province and Nueva Vizcaya Demonstration Project.—The weather condition throughout the district was rather unfavorable, due to excessive rainfall especially in the northern districts of the Mountain Province.

Due to the adaptability of this district to coffee, a great deal of time and effort was concentrated in furthering the growing of this crop. Nurseries had been established, plants distributed and planted, old trees were pruned, cultivated and mulched under the supervision of the inspectors. New varieties of coffee

were also introduced and from all appearances they thrived well. There were 54,465 coffee seedlings of the Robusta and Arabica varieties, 34,700 of which were planted in Lepanto and 19,765 in Bontoc planted during the year.

The tobacco campaign has given good results. In Bontoc subprovince 50,050 seedlings were planted and in Lepanto 21,571.

Isabela and Cagayan Demonstration Project.—The tobacco crop as a whole was rather poor and less tobacco was produced owing to the excessive rains during November and December, 1916, and also during the harvest period. There were 71 coöperators representing an area of 63 hectares. In many cases the tobacco coöperators were also corn coöperators.

There were 69 corn coöperators representing an area of 96 hectares. The coöperators obtained an average of 39 cavans per hectare, while in general only about 22 cavanes per hectare was produced. The corn crop, as a whole, was good.

The rice crop in Isabela was considered very poor. In Cagayan the rice crop was better and the few coöperators obtained an average of 49 cavanes per hectare, 9 cavanes more than the general average.

During the months of June, July, and August 1,465 liters of tobacco seeds were purchased, 900 liters of which were sent to Cagayan, 120 liters to the Bureau of Agriculture, 80 liters to Juan Bunoan, 30.5 liters through the mails, and 58.5 liters to 160 persons.

The tobacco seeds planted during September were almost all destroyed by rain and floods. It was estimated that only one-third of the total seedlings on the seed beds was saved. The scarcity of seeds was felt.

The inspectors in this project were also appointed as special forest officers for the issuance of gratuitous timber licenses for tobacco drying sheds. In Isabela 2,586 of these licenses were issued, while in Cagayan 1,267. However, not more than 600 were energetic enough to build drying sheds during the year.

During the first month of the year the valley was visited by a swarm of locusts, but the activity of the officials and citizens prevailed.

About 43,000 packages of vegetable seeds were distributed during the last quarter and notwithstanding the excessive rains and floods, it was estimated that 10,000 people would be benefited by the home gardens planted.

Ilocos Norte, Ilocos Sur, La Union, Abra, and Amburayan Demonstration Project.—During the first quarter, the climatic

conditions in this district were unfavorable. It was hot, dry and windy, and with only a few showers. Due to this unfavorable condition, it was impossible to plant much corn and sugar cane. However, the weather was favorable for the rice crop.

The number of rice coöperators in this project was 27, representing an area of 86,930 square meters. The average production of these plots was not reported at the end of the year.

Of the nine corn coöperators handled, the production ranged from 30 to 100 cavanes per hectare. The maximum yield was obtained in one of the plots at Narvacan.

Owing to the fact that the tobacco inspectors were appointed late, there were only 26 tobacco coöperators handled. All of the plots were growing nicely. In the whole district there was great interest in tobacco and a great deal more tobacco was planted during the year than in any previous year. Thirty demijohns of Isabela tobacco variety furnished by the Tabacalera Company were distributed in the district.

A total of three provincial and eighteen municipal nurseries were in operation during the year in this project. The materials and labors were furnished gratis by the people concerned. These nurseries were somewhat abandoned during the last quarter, due to the food production and rice seed selection campaigns.

One of the most important works carried on in this district was the food production campaign. About ten sacks of vegetable seeds were distributed. All the assistants assigned in this project were mobilized in this work, and, with the hearty coöperation of the provincial, municipal, insular officials and the people, the campaign produced good results. Home gardens, municipal gardens, and provincial gardens were all in evidence.

The rice seed selection campaign was emphasized more this year than in any year before, especially when the Department of Agriculture and Natural Resources hired laborers to carry on the work. This line of work was very successful and the local officials as well as the farmers coöperated heartily.

The public breeding work in the project progressed satisfactorily. There were fourteen boars (one of which died), and one stallion in use in the whole district.

The only work accomplished in this project was the selection of rice seeds on a large scale as adopted by the Department of Agriculture and Natural Resources. This work was carried on in the municipalities of Tarlac, Victoria, Paniqui, and Camiling. Being a new work and probably partly due to the scarcity of labor and the abundance of good crops, good coöperation was

not available, except in the municipalities of Paniqui and Camiling.

Bulacan Demonstration Project.—During the first four months of the year, it was rather dry and windy, but later on the weather was favorable for sugar cane, corn, and rice.

Of the fourteen plots of corn handled during the year, those planted at Quingua gave the best results. One of the coöperators, produced 21⅓ cavanes on ¼ hectare, or an average of 85.3 cavanes per hectare, while another coöperator, produced 41 cavanes from ½ hectare, or 82 cavanes per hectare. The corn planted during the dry season was rather poor, but the main crop was good.

There were 20 rice coöperators handled during the planting season, but due to the fact that one of the inspectors in charge was transferred, some were dropped. The results of these plots are not reported as yet.

Two sugar plots of Dimarara 1335 and H–20 were planted at Bocaue and San Miguel. At the time the two transferred inspectors left these two districts, the canes in these plots were making a good growth.

The food production campaign was one of the important works carried in this district. Lectures emphasizing the need and means of increasing production of cereals, vegetables, secondary crops and poultry were discussed. Thousands of packages of vegetable seeds were distributed. Local officials, as well as the masses, have responded enthusiastically and home gardens were multiplied.

Being a rice-producing province, the selection of rice seeds was the most important work carried in this project by the inspectors. This line of work was especially emphasized when the Secretary of the Department of Agriculture and Natural Resources hired laborers and foremen to push this work. The work was successfully carried.

The province of Bulacan appropriated ₱1,500 for the establishment and maintenance of a station at Malolos. The first corn crop raised was interplanted with cowpeas and peanuts, in order to improve the rather poor quality of the soil. About four-fifths of the total area of the station was planted to rice during the rainy season. The varieties used were Apostol, Roxas, and Cruz, and also Macan, a local variety. A good crop of rice, considerably better than adjoining fields, was produced.

The nursery has maintained several seedlings of the local varieties of fruit trees, such as mango, chico, tamarind, mabolo,

papaya, cacao, ate, etc., most of which were distributed from time to time.

Bataan and Cavite Demonstration Project.—The weather in Bataan during the first four months of the year was rather hot, and rice as well as corn plots planted in the previous quarter suffered severely.

The rice crop in the district was good as a whole especially the lowland, but the upland was slightly damaged due to drought. The results of the ten coöperative plots (lowland Bureau rice) handled during the year ranged from 31 to 52 cavanes per hectare, while in general the average production was about 20 cavanes. The rice varieties used were Apostol for lowland and Inantipolo for upland. Each coöperator has selected two cavanes of seed for next season.

There were also 20 coöperative corn plots planted during the year. Those planted early in the year suffered from drought, but the main crop was good. Sincamas plots were also maintained to demonstrate the advantage of proper cultivation.

The most important projects carried on during the year were the food campaign, rice seed selection, and the establishment of a small provincial nursery. In the food campaign lectures on agricultural topics were discussed and vegetable seeds distributed. In the seed selection of rice, many farmers were helped, but the majority could not afford to select, due to the scarcity of labor.

The Demonstration Station of Balanga.—This was established with an appropriation of ₱150. It was the smallest nursery established during the year in any province in the Islands. Due to the limited space of the nursery, no other work but the propagation of plants for distribution could be undertaken.

Ambos Camarines Demonstration Project.—The agricultural demonstration work in this province was started last April, when the provincial board appropriated the sum of ₱1,000 for the establishment and maintenance of a nursery.

The weather condition was favorable throughout the district, but during October a flood occurred which destroyed rice in low lying district.

Being a rice producing province, the most important work carried in this project related to the improvement of this crop was the introduction of the improved Bureau varieties, better cultivation, and seed selection from local varieties. Fifteen coöperators of Apostol, Roxas, and Conner varieties were secured. The results of these plots will be reported later.

The demonstration station was planted to different vege-

tables, cowpeas, corn, and peanuts all the year around. The results obtained were all satisfactory. Cacao and coffee were also planted in the nursery for distribution purposes. The lowland portion of the nursery could not be planted to rice, since the province could not furnish a work animal.

The food campaign carried in this project produced satisfactory results. Every municipality had its garden where vegetable seedlings for distribution to the farmers were maintained. The provincial and municipal officials coöperated efficiently with the inspectors. Vegetable seeds were distributed by the thousands in packages.

The rice seed selection campaign, as outlined by the Secretary of Agriculture and Natural Resources, was also carried in this province. The farmers, as well as all officials concerned, were enthusiastic about this work. Coöperation could not be had on a large scale, due to the scarcity of labor.

Rizal Demonstration Project.—The weather was so warm during the first quarter that agricultural operation on a large scale could not be undertaken. The weather was favorable, however, for rice.

The three plots of rice which were not reported in 1916 produced good results. The Apostol variety gave an average of 42 cavanes, while the Cruz variety 65 cavanes.

Much attention was devoted to the selection of rice seed of the 1916–17 crop. Municipal officials, as well as numbers of agricultural societies coöperated heartily in this work and 68 cavanes of rice were selected for 117 farmers.

Most of the garden days celebrated in Rizal were attended by the inspectors. Vegetable seeds, plants and circulars were distributed and agricultural topics discussed.

The sugar-cane demonstration plot at Pasig has produced 5,000 points of yellow Caledonia, 4,900 of Louisiana striped, 4,000 of H–309 and 1,000 of H–69, and also ₱12 worth of cane sold. All of the points were distributed to farmers in Pasig, Mariquina, and San Mateo. All of these canes have grown satisfactorily.

The selection of rice seed on a large scale, as outlined by the Department Secretary, was also carried out with success.

The campaign for producing more food stuffs was also carried on with vigor and thousands of packages of vegetable seeds were distributed.

Laguna Demonstration Project.—The weather during the first quarter was hot and dry, with a shower every ten or fifteen days in the lowland, while in the upland, there were frequent

rains. The drought during August affected somewhat the upland rice, but the lowland was good in every respect. Weather conditions also favored all other crops.

Being decidedly a rice producing province, the most important work carried in this project was that related to the improvement of cultivation and increase in production of rice. Instruction in seed selection on a large scale was successfully carried out and the inspectors were kept busy attending and instructing the farmers in this line of work. During the first quarter, a total of 387 gantas of seed rice were selected by the inspectors and the farmers. Three thousand gantas of all of these seeds were used in planting last season. The two plots of rice harvested during the first quarter gave an average of 59 cavanes per hectare, while, in general, about 35 cavanes were obtained. There were 32 rice coöperators maintained during the year, producing from 57 to 156 cavanes per hectare. The selection of rice seed on a large scale was also carried out during the last quarter with good results.

An excellent crop of corn was harvested by eight corn coöperators handled in the district, with a yield ranging from 40 to 86 cavanes per hectare. By carrying a vigorous food production campaign, the farmers throughout the province have harvested an excellent crop of sweet potatoes, squash, garlic, gabi, and other vegetables. Gabi was selling at 25 to 35 centavos per sack. Vegetables were so abundant that farmers had difficulty in disposing of all of their products.

Santa Cruz Demonstration Station.—The work at the station has been carried out successfully, especially during the first quarter of the year. During the third quarter, the ground was too wet to work, but later on the station was put in good condition. Large amounts of vegetable seeds and seedlings, and also coffee, were raised for distribution among the farmers. One-half hectare of native yellow corn gave a yield of 41.5 cavanes of shelled corn. Vegetables were planted on a large scale. The gabi plot planted at the station produced an average of 160 cavanes per hectare. At the end of the year, there were planted at the station $\frac{1}{4}$ hectare of tomatoes, $\frac{1}{4}$ hectare of Irish potatoes, $\frac{1}{4}$ hectare of different varieties of beans, $\frac{1}{4}$ hectare of American sweet corn, and a plot of vegetables. One hundred Liberian coffee seedlings were also planted all of which were in excellent condition at the close of the year.

Pangasinan Demonstration Project.—On account of the prevalence of locusts in the first two months in the province of

Pangasinan, as well as in the neighboring provinces, the entire field force of this project was loaned to the pest control section for detail in the locust work. Very little attention could therefore be given to agricultural demonstration work during the said period.

From the beginning of the year until the middle of March, the weather was dry. The early planted tobacco plants were affected by the drought, but the late ones have produced better results. The tobacco crop produced was considered greater than the year previous. The tobacco plot, consisting of 12,000 square meters, has yielded two thousand manos.

Due partly to the high price paid for tobacco last year and principally to the campaign carried by the assistant agricultural inspectors, as well as tobacco inspectors in this province, a considerable area has been planted, an area estimated to be more than that corresponding to the previous year. There were twenty-one coöperators handled during the year. The tobacco seedlings planted so far were growing nicely.

During the year, there were twenty-two coöperative plots of rice maintained. All of these plots have shown up satisfactorily and the yields, some of which were expected to be exceptionally good, will be reported as soon as threshed out. All of the seed used in these used plots was selected. The selection of rice seed was carried to its full extent this year, especially when the Department of Agriculture and Natural Resources employed foremen and laborers for this purpose. About twenty thousand farmers were helped in the selection of rice seed. The local officials, as well as the farmers, were greatly interested in this work and good coöperation by those in charge of the work was given. The rice crop, as a whole, in the province was considered better than the preceding year.

The food production campaign was also one of the most important works carried during the year. Several lectures on several ocasions were given with large attendance and thousands of packages of vegetable seeds were distributed. The masses have responded enthusiastically in this campaign and fine home gardens were found almost everywhere. There were 260 garden coöperators handled during the year.

Nueva Ecija Demonstration Project.—Inspectors were stationed in this project for the purpose of making a campaign in increased production, as well as improvement of the quality of tobacco. Due to the campaign carried out in the province, larger area was planted to this crop than in any previous year.

The quality of the crop produced was better and the quantity increased. Great interest among the farmers was manifested and large areas were already planted at the end of the year.

The campaign for food production, as well as selection of rice seed was also carried out in this province. The farmers were interested in the selection of seed, but due to a bountiful crop of rice and the scarcity of laborers, not much coöperation could be rendered.

Pampanga Demonstration Project.—As in the case of many of the other projects, the weather condition in Pampanga during the first quarter was dry, as a whole. The planting of secondary crops could only be carried in places where irrigation was available. The weather was, however, favorable for sugar cane, rice, and the main crop of corn.

The number of Moro corn coöperators handled during the year was seven in all. This corn has made satisfactory showing and in one of the plots an average of 72 cavanes per hectare was obtained. Farmers were, however, reluctant in planting this on a large scale, due to its susceptibility to weevil attacks and other pests. Other plots handled were two plots of Momungan sweet potatoes, five plots of peanuts, and two of sugar cane, and six plots of rice. The plot of sugar cane was for the purpose of demonstrating to the people the advantages of selected points, introduction of foreign variety, wider distance in planting and irrigation. The plots were a success and people were convinced of the practicability of changing the old method of planting. Most of the rice coöperators were satisfied with the yields obtained, while others were disappointed, due to negligence in weeding their rice fields. The yields will be reported later.

Other important works carried during the year were the food production and the rice seed selection campaigns. Both of these campaigns were a success. In the food campaign several lectures were delivered in all the municipalities and tens of thousand of packages of vegetable seeds distributed to the farmers. The provincial, as well as municipal officials coöperated effectively in this campaign and, as a result, many fine home gardens were maintained. The rice seed selection campaign was also a success.

Mexico Demonstration Station.—The expenses incurred in the establishment and maintenance of this station were born by the municipality of Mexico until the fourth quarter, when the province appropriated an amount of money to carry the work on on a larger scale. The station was increased to 4

hectares in area and three work animals were purchased. Three laborers were maintained by the province and one by the Bureau of Agriculture.

Part of the station was planted to vegetables all the year round and a considerable amount of the product was sold in the market. At the end of the year, there were found plots of Moro corn Iowa Ideal, and native corn, sugar cane plots of both native and imported varieties, plot of different vegetables and numerous seedlings of different fruit trees in the nursery. This station promises to be one of the best stations of the demonstration division.

Bohol Demonstration Project.—The weather conditions throughout the year were favorable to rice, but for corn, it was rather unfavorable. There was too much rain.

The most important works carried during the year were food production campaign, seed selection campaign and the establishment of the provincial nursery. Lectures were delivered in all accessible municipalities and vegetable seeds and seedlings were distributed. Almost every municipality had its vegetable garden and home gardens were numerous.

In the selection of rice seed the intelligent farmers were greatly interested since accounts of the results of rice plots in Laguna province has reached them. Many farmers were helped in seed selection and in spite of the fact that the work was new to the people, it was successful. In the Bohol Rice Colony alone, 98 cavanes were selected or one cavan per colonist. In connection with this work, the provincial board allotted ₱10,000 for the purchase of selected seeds to be resold later to the needy farmers. The rice crop was good. Besides rice, corn seed was also selected.

The establishing of the provincial nursery in the municipality of Carmen was started last May. The provincial board appropriated ₱1,500 for its maintenance. The station contains 14 hectares of cogon land.

Mindoro Demonstration Project.—The most important works carried in this district were the food production campaign and selection of rice seed. The food campaign could be considered the most effective, since most of the vegetables used in Calapan and neigboring towns were formerly either imported from Manila or from Batangas. Lectures were delivered in many places urging the people to raise enough vegetables for their own use. Vegetable seeds were distributed with planting instructions. As a result of the campaign, many home gardens were maintained.

Due to the lack of personnel, the campaign of rice seed selection was only carried in Calapan. Many farmers were instructed in this line of work.

Notwithstanding the fact that the provincial board of Mindoro was the first province to appropriate money for the establishment and maintenance of a nursery, yet for some reasons or other, the work had to be delayed until December, when the provincial board finally purchased the piece of land intended for the nursery. Work on sheds and plots was only started at the end of the year.

Samar Demonstration Project.—The work carried out during the year was for the food campaign, rice seed selection, and the establishment of the provincial nursery. In the food campaign, lectures on different agricultural topics were discussed and vegetable seeds distributed. In the selection of rice seed, many farmers were also helped, but due to the lack of good means of transportation, the sphere of the work was limited from Catbalogan. Preparatory work in the nursery, such as fencing, building sheds and digging stump was accomplished. The work was greatly handicapped, owing to the fact that the provincial government failed to obtain even a single work animal.

RURAL CREDIT SECTION.

Eight rural credit associations were incorporated between October, 1916, when the work was started, and January 1, 1917. During the year 1917 seventy-four more associations were incorporated, and 142 other associations were organized, the capital of which has not been entirely paid in, so these have not yet incorporated.

The 82 associations in existence January 1, 1918, are distributed widely throughout the Archipelago.

We have no figures that show the actual capital now on hand. Shares are being constantly sold in every association, and in no association has capital been withdrawn. Complete statistics are not on hand. Most of the 82 associations have had less than six months existence and only 8 have had a full year since organizing. In the case of Sibalom the above table shows a capital of ₱270, while in fact they have a share capital of ₱2,324 paid in; Balanga appears in the above as having ₱250 while their paid in capital is ₱898; Samal appears as ₱250 while their paid in capital is ₱1,378. All associations have not as marked an increase as the above, *but all have advanced,* and San Miguel, Malasiqui, San Carlos, and Mexico have passed the

₱3,000 mark. The paid in capital to-day is nearer the ₱100,000 mark than the ₱41,483 tabulated above.

It was no light matter to introduce an entirely new plan and to instill a sense of individual responsibility in the members by obligating them to assume all the work and responsibility to make these rural credit associations really self managing and self propagating. It would often have been easier to have stepped in and managed their affairs than to have patiently taught the much needed lesson of self-dependence and self-reliance. The degree of success attained is partly due to the merciless exactions of the usurers which have driven the public patience almost to exasperation so that any suggested relief looked good, while the indorsement of public-spirited men in all walks of life satisfied all that the proposed village bank was worthy of confidence. There is no need to argue or convince people of the utility or necessity of these associations. This is being effectively done by friends of the cause in each community, who explain the details and remove the fears of the timid. A word of recommendation of rural credit by a man in whom the masses believe, is more effective than a convincing speech by an outsider. It is also proper to state that these friendly advocates received their information and inspiration largely from the press, whose columns are unstintingly open to the Bureau to give wider publicity to rural credit items and happenings in various towns, thus educating and enthusing persons in remote barrios. So really, as a consequence of these preparatory agencies, the ground had been plowed, the seed had been sown and usually it was the agreeable task of the agents to be invited to come and make out the incorporation papers, advise in preparing by-laws, and to instruct the boards of directors in their duties to the members and to the associations and start them off right.

Personal supervision and advice has been fragmentary and irregular owing to the limited number of agents and the numerous calls for matters not of greater importance, but which appeared more pressing. Correspondence at best is a mere makesshift for conveying thought or securing action. Letters are easily laid aside while the human monitor insists on something being done and is able to answer objection and suggest lines of action and can also be sure that the person addressed really understands the matter at issue.

Working of associations.—It has been a constant surprise to note the facility with which the associations have carried on their work when once the details of the plan were understood by the members. The Corporation Law requires that the incor-

porators, who can not exceed 15 in number, must select five as directors, these to serve until at a regular meeting of the shareholders, to be held at a time fixed in their by-laws, when a new board is elected. The familiarity with municipal procedure makes conducting the affairs of an association an easy task, as is also the keeping of the minute and other details.

The law (Act No. 2508) appoints the municipal treasurers as exofficio treasurers of the associations and the Insular Auditor as auditor of the accounts. These two wise provisions have silenced all doubts as to wether money can be safely entrusted to the associations by prospective shareholders. Nothing has contributed more to place these associations in the highest place in the confidence of the public, a place we will always strive to maintain. The boards of directors received applications for loans. These are either approved or disapproved. If approved a voucher or cheque is drawn on the treasurer, who pays the money to the borrower.

There are cases where the boards of directors were selected on account of the social standing and prominence of the men rather than on the grounds of a desire to advance the economic interests of agriculture and supply necessary loans to the needy farmers. It has required rare tact and diplomacy to induce such to resign without giving offense and creating opposition. We have tolerated inaction in some cases rather than to create dissension.

Rural credit agents.—It is a pleasure to put on record the hearty appreciation of the loyal, efficient service which these agents have cheerfully rendered at all times. Each one is anxious to learn all that can be known about rural credit, and without exception each has gladly served his countrymen and sought to explain the possibilities of rural credit in its bearing on the individual, the town, the province, and the whole country. That they have succeeded in a marked degree is shown by the results already achieved. These agents have been invited by governors, senators, representatives, municipal officers, and public spirited individuals to come and asist in campaigns. They have been sent and in every case have they shown ability, keen interest, and gentlemanly qualities of the highest order. More agents are absolutely necessary to successfully supervise and develop this rapidly growing work. These new associations need advice. They need some experienced person to encourage and guide the members and officers at the start. They meet many perplexities in law Act No. 2508 and its application which

can be explained. They start with a small capital and small experience. Some one must cheer them during the formation period when they often look at the height of the financial hill they have to climb and the small start they have made. A few words of encouragement and counsel works wonders. It is a serious ommission not to follow up each association by frequent visits during which the wide-awake agent can tactfully help them in a hundred ways.

Results.—As previously stated, every one of the 82 associations has advanced in the matter of increasing its capital and membership. Partial reports on "Amount loaned and the number of borrowers," show that in only a few instances have the associations remained inactive and these have begun with the new year. Complete returns are not at hand.

It is impossible in this limited report to mention each one of the 82 associations. It is true there are a few associations under very low pressure, hence advancing very slowly; with a larger force of agents these will be speeded up. Most of the associations are new and hence inexperienced, but they are cheerfully doing the best they know how, and willingly learning from the circulars and letters sent out frequently and any visits paid by agents. The agents are also learning by experience and next year will render better service. It is hoped that they will continue to receive the cordial esteem and respect that is now extended. During the year under review not one questionable or suspicious act occured in any association. Nor has any accusation been made against any agent, or any officer, or any member of any association.

COÖPERATIVE ORGANIZATION AND COÖPERATIVE MARKETING SECTION.

Status of the section at the beginning of the year.—There were twenty-nine provincial agricultural societies as follows: Albay, Bataan, Batangas, Bohol, Bulacan, Camarines, Capiz, Cavite, Cebu, Ilocos Norte, Ilocos Sur, Iloilo, Laguna, La Union, Leyte, Mindoro, Occidental Negros, Oriental Negros, Nueva Ecija, Palawan, Pampanga, Pangasinan, Rizal, Samar, Sorsogon, Surigao, Tarlac, Tayabas, and Zambales. Ten of these societies have held elections of new officers for the year 1918. Besides these societies there were 280 municipal agricultural societies, scattered in the above-named provinces. Twenty-three municipal agricultural societies have held new election of officers for the year 1918.

Plan of work.—The work of this section consisted of:

(*a*) The continuation of the issuing of a weekly market report of Manila prices of staple farm products.

(*b*) The mailing of the Philippine Farmer free to all members of all agricultural societies, to some employees of the Bureau, to division superintendents of schools, to some supervising teachers and principal, to members of the Philippine Legislature and some foreign agricultural institutions and libraries.

(*c*) The receipt of a weekly cable of prices on the New York sugar market, the same being repeated promptly by wire to the following sugar producing provinces: Occidental Negros, Oriental Negros, Iloilo, Pampanga, and Batangas.

(*d*) To extend information concerning the benefits of coöperation and to encourage and assist the forming of coöperative enterprises among the members of the agricultural societies.

(*e*) Through the organization to bring the farmers and the Bureau of Agriculture in closer touch, thus helping the farmer and increasing the effectiveness of the Bureau.

(*f*) To establish a communication through this office among the societies with the end of furnishing them a market for the disposal of their surplus products and facilitate a cheaper and easier way of buying merchandise needed for their local consumption.

During the month of April the acting chief visited several municipal agricultural societies at Iloilo and Negros. The societies visited were found to be doing good for the benefit of the farmers. He also visited the provinces of Bulacan, Cavite, Nueva Ecija, Tayabas, Laguna, and Batangas to study the conditions of the provincial as well as municipal societies. Most of these associations visited were doing good work, and those which were indifferent were aroused to an active life by giving them hints and suggestions as to the proper way of undertaking business.

To this office falls the duty of computing the Manila weekly market report issued by this Bureau. In order to obtain data for this report it is necessary to visit several important commercial houses to confer with the manager in regard to prices of the most important crops of the Islands. This report contains market prices on abaca, maguey or sisal, pacol, sugar, corn, rice, tobacco, and live stock. This is sent to presidents, vice-presidents, and secretary-treasurers of provincial agricultural societies; to Bureau field men, to banks and commercial houses, press in Manila, and several leading fiber concerns in

foreign countries. The New York price on 96° centrifugal sugar is received by cable from the Bureau of Insular Affairs by the Philippine Government and this is promptly repeated by telegraph to the five leading sugar producing provinces, and to other provinces from time to time by wire when requested. This market report is one of the most important works of the Bureau which has a direct and beneficial results with the farmers of these Islands.

The following will give a brief statement of some of the activities accomplished by the agricultural societies during the year:

The very active president of the agricultural society of Ambos Camarines, Mr. Andres Garchitorena, has undertaken in another way to improve the agricultural conditions of his province. He bought several modern plows and sent them to the different towns for sale at original price. He even suggested to raffle them for ₱0.50 or ₱1 among the small farmers, those who wanted to own a plow but were too poor to buy one. His idea was to let the people become acquainted with the use of a modern plow.

The societies in Mindoro have emphasized the planting of bananas. Lectures in which the importance of the bananas as a food was explained were successfully conducted and as a result the land planted to this crop has increased a great deal.

The municipal agricultural society of San Miguel, Bulacan, had made combinations with the teachers and established its activities among the barrios. Lectures had been conducted in the barrio school buildings. Contents of the Philippine Farmers were translated to Tagalog and read in these conferences every month.

The organized associations have served an important factor in the success acquired by the food production campaign. Almost all the societies have taken a keen interest and responded to the call. As a result a big quantity of seed has been distributed throughout these societies. In many cases every individual member of a society started a home garden to supply himself and family.

The provincial agricultural society of Surigao has been active during the year in putting all the uncleared space in the municipality under cultivation. For this reason a petition was submitted to the Director of Forestry to the effect that certain provisions of the regulations of the Bureau of Forestry be amended.

The phase of work undertaken by a great number of societies,

among them can be cited the municipal agricultural society of Dalaguete, Cebu, was the improvement of both quantity and quality of their crops. Prizes have been offered to encourage the members to extend their cultivation and to use improved methods.

During the year eleven new municipalities were organized. It shows that coöperation is still growing.

INSURANCE SECTION.

History of the insurance section.—Early in the year 1916, Act No. 2573 was passed by the Philippine Legislature providing for the establishment of the work animals insurance under the control and supervision of the animal Insurance Board, composed of the Director of Agriculture, as chairman, and the Insular Treasurer and one agriculturist, as members and creating a new section in the central office of the Bureau of Agriculture known as "Insurance section."

This section was not formally inaugurated until the beginning of 1917, subsequent to the amendment of Act No. 2573 by Act No. 2682, providing among other things for the reduction of the number of heads of animals necessary to start with the operation of the insurance, and for the changes in the members of the Insurance Board, to be composed of the Director of Agriculture, as chairman, and two private citizens, one of them acquainted with and interested in agriculture and the other in cattle breeding, as members.

Work of the insurance section.—The work of the former Insurance Board was reduced simply to the holding of a meeting on March 16, 1916, adopting three resolutions on the preliminary steps toward bringing about the enforcement of animal insurance. These resolutions consisted of a request to the Director of Agriculture for the printing of all papers, circulars, blank forms, booklets, etc., and of the fixing of the schedule of values for insuring animals.

As soon as the new board was duly constituted, its first meeting was held May 16, 1917. A resolution was passed adopting and approving the former board's resolutions save the schedule of values which was made entirely ineffective.

The Insurance Board held various meetings during the last year, which meetings dealt mainly with the preparatory steps with a view to enforcing the insurance law by approving the required papers relative to the management of the insurance society such as the by-laws and regulations governing animal insurance.

On June 25, 1917, the board adopted a resolution providing for the securing of necessary data concerning the local market value of work animals in the leading provinces of the Islands, and the listing of the animal owners desiring to insure their animals when the law is made operative. Accordingly, the two agents were immediately sent out to the provinces to collect data relative to the local market prices of work animals, to confer with the owners thereof as to the advisability of the operation of the Insurance Law, and to list those who might be willing to have their animals insured. These agents visited the provinces of Batangas, Bulacan, Pampanga, and Iloilo, the result of their work being the acquisition of sufficient data on the local prices of animals in those provinces, which data were reported to, and presented for, the consideration of the Insurance Board. In the province of Iloilo there has been listed a considerable number of proprietors who are ready to take advantage of the insurance as soon as it is in force.

Judging from the reports of these agents, hardships had to be encountered by them in listing the animal owners, because of the rate of the premiums which the people deem to be so high that they would prefer not to insure their animals rather than to bear an onerous yearly burden constituting a demandable obligation on their part. So they suggested that the rate of the premium be reduced accordingly so as to make it bearable even by the poorest land or animal owners. This suggestion has been made known to the Insurance Board. On the other hand, the sway of the rinderpest prevailing for the entire year in the majority of the provinces was another reason which hindered the enforcement of the insurance society, and unless this calamity is checked there is doubt as to the securing of the minimum number of head provided for in the law as a necessary condition for its operation.

OBSERVATIONS ON AGRICULTURE IN THE MOUNTAIN PROVINCE.[1]

By P. J. WESTER, *Formerly Superintendent, Lamao Experiment Station.*

The mountain Province is the second province in the Philippines, of which only an infinitesimal part of its area is under cultivation, and it has undoubtedly larger areas differing in climatic conditions and perhaps wider variations in crop adaptability within an equal area than any other province in the Archipelago. This is due to the formation of the land, which, generally speaking, is mountainous and rugged in the extreme, even to a point where the land becomes too precipitous for agricultural purposes; then, the altitudes and the deflection of the air currents by the mountains cause a great variation in humidity and rainfall. This combines to make a highly diversified climate within very circumscribed areas, or in other words, certain localities even within a municipality may be adapted to a certain crop while another locality in the same municipality is not adapted to it. For this reason the recommendations given hereinafter must necessarily be general in character; specific recommendations relative to agriculture in the various municipalities are very difficult to give without numerous repetitions, in fact, they could not authoritatively be given without a lengthy stay in the province.

In the list that follows the altitude of a number of municipalities are given. Most of them have been obtained from a chart prepared by Mr. D. B. Mackie of this Bureau, the common measures having been converted to the metric system. The altitudes for the other municipalities were taken by the writer with the aid of an aneroid barometer during his visit to those municipalities. The subprovinces are indicated by the following abbreviations: A., Amburayan; B., Benguet; Bo., Bontoc; I., Ifugao; K., Kalinga; L., Lepanto.

	Meters.		Meters.
Aaay, I	690	Alonogan Bo	810
Abuanan, I	930	Ambabag, I	720
Acups, B	1,320	Ambayoan, Bo	1,140
Adaoay, B	990	Ambuclao, B	660
Alap, Bo	870	Ampatingan, K	420
Aliuan, Bo	750	Ampusungan, L	1,260
Alolino, L	540	Amsuling, B	1,530

[1] Extracts from a report made September 1, 1916, by P. J. Wester, Horticulturist, to the Director of Agriculture, after a six weeks' trip through the Mountain Province during May and June of that year.

	Meters.
Anab, I	630
Apunao, B	1,440
Ausip, B	1,620
Awa, I	1,020
Bacun, A	1,260
Baduios, L	570
Badulo, L	660
Baguio, B	1,410
Balbalan, K	900
Balili, Bo	990
Baload, B	720
Banaue, I	1,020
Bangad, K	510
Barlig, Bo	1,410
Basao, Bo	540
Bauko, L	1,320
Bayong, I	990
Basao, L	1,590
Batogan, L	1,860
Bila, B	1,380
Bokod, B	960
Bontoc, Bo	810
Bugaoy, I	900
Bugnay, Bo	570
Buguias, B	1,470
Bukud, B	1,290
Bulalacao, L	1,440
Bunagon, B	1,290
Butak, A	240
Câgnen, L	1,550
Calitan, K	360
Cayabyab, L	1,320
Cervantes, L	480
Cobang, L	1,290
Comillas, L	510
Conogon, Bo	1,110
Côplow, B	1,050
Coplow, L	1,710
Curog, I	660
Cuscusnong, A	210
Daklang, B	1,260
Damag, I	570
Danter, I	870
Darlican, I	960
Dinapugan, I	720
Ducaur, B	1,440
Ducligan, I	540
Gambang, B	1,590
Gañgab, Bo	780
Gubgub, K	150
Guinsdan, L	1,200
Habangan, I	750
Hapao, I	960
Hunduan, I	1,080
Inticak, B	840
Kabayan, B	1,140
Kabitin, L.	810
Kadaklan, Bo	1,290
Kapangan, B	930
Kayam, L	1,020
Kiangan, I	720
Kibugan, B	1,080
Kimpuan, A	120
Kinking, I	780
Kinna, I	840
Kisang, I	1,260
Kolalo, L	690
Kutapic, I	1,170
Latagin, I	990
Legleg, B	780
Lewong, B	1,590
Lias, Bo	1,260
Lias-Kadaklan Dividel	635
Limus, K	210
Lobo, B	1,860
Lonsa, I	870
Los, B	1,620
Lubon, L	1,020
Lubuagan, K	810
Lutab, B	1,170
Magingi, I	690
Magkoc, I	900
Mahontot, K	390
Maling, B	1,710
Mamabui, Bo	750
Mangcayang, I	570
Mankayan, L	1,230
Mayayao, I	930
Mungayan, I	540
Munhuyuhuy, I	2,010
Nabuñga Ford, B	510
Naiba, L	960
Naneng, K	240
Natonin, Bo	930
Otokan, L	1,110
Paadan, I	1,050
Pacaol, I	840
Paginoo, B	1,260
Palina, B	1,230
Pangpang, B	1,560
Pastor, Bo	210
Pawai, B	2,460
Payauan, I	360
Piakad, I	810

Relief map of Northern Luzon showing topography of Mountain Province.

	Meters.		Meters.
Pickake, B	690	Takian, B	1,200
Pinucpuc, K	50	Talubin, Bo	960
Pitaoan, I	1,110	Tiing, Bo	840
Podugan, B	870	Tinglayan, Bo	510
Pugo, I	1,140	Tiuong, I	810
Sabay, I	480	Tomiangan, K	250
Sabita, B	1,410	Tonlayan, Bo	840
Sagada, Bo	1,560	Trinidad, B	1,110
Sagpal, B	1,320	Tublay, B	810
Samoki, Bo	780	Tue, L	840
Sopeng, L	990	Tugmok, K	540
Suyo, A	90	Tukukan, Bo	870
Tabio, L	1,410	Ungol, I	600
Tadian, L	1,200	Ursadan, A	60
Taga, K	75	Wangwang, I	780

The development of the Mountain Province would necessarily have to proceed along the same lines as that of any other country, viz.: (1) The production of a local food supply, and other necessities; and (2) the production of an article of export in exchange for such necessities as cannot be produced locally.

In the first group, the production of a food supply is of course the most important, after which comes the production of fiber plants for cloth. Other plants are here of minor importance.

Among the agronomic crops rice and camotes are the most important, while corn, beans, ubi, gabi, borona, cucurbits, cowpeas, patani, and sugar cane also play a greater or less rôle as plants of subsistence. Other plants are grown of course but only sporadically and can scarcely be considered important alimentary plants.

The quality desired in the rice by the inhabitants of the Mountain Province is somewhat different from that required by the Filipino in the lowlands, and it has been demonstrated that varieties of a high yield in the lowlands frequently fail to produce at the same rate when planted at a higher altitude, due probably, to some extent, to other circumstances also, such as soil and humidity. Therefore, the improvement of the rice, the need of which is very evident, should primarily consist of the breeding of local varieties which are acclimatized and the quality of which meets the demand of the people; introduction of new varieties is here of secondary importance.

Corn should occupy a position of vastly greater importance than at present, and comparative yield tests such as suggested for camotes, with the subsequent breeding of the best types, is recommended. In addition, the importation of other varieties

with a greater yield from the lowlands of the Philippines would be advisable, and possibly the trial on a small scale of some of the best flint-corn varieties in the United States.

Improved camotes have been introduced and are grown together with the several native kinds. It would be desirable to submit all these varieties to comparative-yield tests at least in two or three municipalities in each subprovince, and at the same time test out as many varieties as it is practicable to obtain from the lowlands.

What is true of the camote applies equally well to the gabi and possibly to the ubi. However, it is probably true that the mere change of cultural methods in the ubi would greatly increase the yield of the varieties now in cultivation. Contrary to the acknowledged best practice of growing ubis, which is to set out a tuber for seed at least 0.5 kilogram in weight, planted not closer than 75 by 150 centimeters, and allowing the plants to run on bamboo poles for support, the custom in the Mountain Province is to cut the tubers into small pieces which are set out 30 centimeters or a little more apart, the plants being left to run on the ground without any support whatever.

The sesame or linga was introduced many years ago and is well acclimatized, yet I saw it nowhere grown as a crop though it is said to succeed well at low and medium elevations. Together with some legume, sesame would serve excellently to balance and enrich the food ration of the people, and its extended culture cannot be too strongly recommended.

The planting of mungos, anipay, cowpea, beans, limas, cadios, and other legumes in the respective localities where these legumes will thrive should be encouraged.

The introduction of the yautia, which is a greater yielder than the gabi, with a somewhat higher starch content, is also to be recommended. The cultivation of cassava should be extended in the low and medium elevations.

Considering the comparative isolation and inaccessability of the Mountain Province it was a matter of considerable surprise to find that all agronomic crop plants and all the more important vegetables had been introduced, and it would appear that corn, camotes, yautias, and temparate annual vegetable excepted, little is to be gained by new introduction from the lowlands. On the other hand the fruits are not well represented beyond Cervantes, and where there are proper facilities for nursery work much good could undoubtedly be accomplished by starting nurseries in the low and medium elevations for local distribution or fruit trees of most of the fruits common in other parts

of the Philippines, and by the introduction of semitropical fruits to the high altitudes.

It is gratifying to record a small but substantial introduction of the cherimoya, the best of all the subtropical fruits, in several parts of the province. The khaki thrives and fruits to perfection in Sagada, and the chestnut has fruited for many years in Mankayan, with several young trees making excellent growth in Sagada.

The Cubili, *Cubilia blancoi,* or Atilang, as it is known here, grows wild at medium to low elevations in Lepanto, Kalinga and Ifugao, and probably elsewhere. This is a nut of exceptional value, fully equal to the chestnut in flavor and quality. Orchards of this tree from 1 to 2 hectares in extent in each settlement would furnish excellent, wholesome, and nutritious food in great abundance at a very slight expense for a part of the year. The planting of coconuts should be encouraged below an altitude of 700 meters.

Fiber plants that may be considered for cultivation in the Mountain Province include cotton, ramie, maguey, roselle, and jute. Cotton, ramie, and maguey have already been introduced, but neither are sufficiently extensively cultivated to deserve the same as an agricultural crop, at least so far as I noted.

In order to bring about improvement in the production of cotton, it would be well to obtain seeds of all the varieties introduced for comparative tests in localities differing in altitude and rainfall, and also to introduce and similarly test the various cottons cultivated in other parts of the Philippines. This accomplished, the best varieties should be increased for dissemination as rapidly as possible.

The field properly prepared and free from serious weeds such as cogon, the ramie is a plant of easy culture, and it yields an unusually strong fiber the cloth of which has excellent wearing qualities. It is easily propagated by the division of the roots. As already stated the ramie has been introduced and all that is required is to extend the cultivation of the plant, which is recommended particularly for the low and medium elevations. The Bureau of Agriculture has introduced ramie from Java, and it would undoubtedly be well to test this variety also in the Mountain Province. Considering the susceptibility to insect attacks of the cotton plant and the relative immunity of the ramie to all plant pests, it is well within the range of possibilities that the ramie may be the one fiber plant best suited to the local needs for the manufacture of cloth in the Mountain Province.

In considering the possibility of coffee as an export crop it would also be well to provide for the local manufacture of the bags necessary to exporting the coffee. There is scarcely any doubt but that the Altissima roselle and the jute would succeed in the low and medium elevation of the province, both of which produce a fiber of good quality for bagging. Nevertheless, it would be well to make trial plantings of both these plants in several localities where coffee is being grown before extensive plantings are made.

The mountainous island of Corsica is a good example of correct farming on steep hills and mountain side in order to conserve and maintain the fertility of the soil. Such land has there been planted to nut and fruit trees, particularly nut-bearing plants, for many years, with good sucess. The same system has more recently been advocated for certain regions of the United States. It might well be adopted in the Mountain Province on land where the cost of terracing would be excessive, and the annual crops grown on terraced and the gently sloping land.

I would call especial attention to the need of the people of information relative to the advantages and the importance of crop rotation, proper preparation of the land before the planting of the crops and finally to the necessity of proper attention to the growing crops, both in the observance of intelligent and sufficient spacing of the plants at the time of planting and in their subsequent weeding and culture. There can be no question whatever, but that these matters carefully attended to, the yield of the crops would be increased very materially without extending the area cultivated.

Owing to the long distance of transportation to the market with consequent heavy freight charges, the production of many articles for export that are profitable in order parts of the Archipelago in other words, perishable or bulky goods with a relatively low value per weight unit cannot be considered in the Mountain Province.

Among possible export products the raising of live stock which could be driven over the mountain ranges to the markets of the lowlands might be considered.

Every thing taken into consideration, it is doubtful whether the benefits obtained through the importation of stallions and bulls for the improvement of the cattle would be commensurate with the cost. The introduction of better grade boars for the improvement of the hogs appears more promising.

In order to encourage the exportation of animals every thing

that can, should be done to facilitate the movement of live stock from the Mountain Province to the lowlands.

Maguey has been introduced into many municipalities and would in all probability produce a good fiber in the hot and comparatively dry region beyond Cervantes towards Angaki and beyond this township. It would therefore be well to here investigate the transportation costs between the coast and those points, with a view of encouraging maguey production, if freight charges are such as to leave the grower a reasonable profit.

However, from the present outlook coffee appears to be the most promising export crop in the Mountain Province.

Considering the subprovinces for the production of coffee so far as observations were made, Lepanto and Bontoc seem to have the largest territory adapted to Arabian coffee, for instance, the district including Kayam, Lubon, Bauko, and Sagada. Lepanto was not visited south of Cervantes. Cervantes is too low for Arabian coffee and possibly too dry for Robusta, but Excelsa should thrive well. This is also undoubtedly the best coffee for northern Lepanto in Angaki toward San Emilio. The Bontoc region with adjacent territory towards Talubin in the south, and well toward Tinglayan in the northeast, is not a good agricultural country, generally speaking. Beyond Talubin, going toward Barlig and Lias, the character of the landscape changes for the better, and up to the divide between Lias and Kadaklan there are large bodies of land evidently well adapted to Arabian coffee, and also the tea and cinchona.

Following the Chico River from Bontoc to Tinglayan, there is a gradual descent. Here Robusta and Excelsa coffee are worthy of trial. Beyond Tinglayan there is a gradual rise to Lubuagan. Here and from here on to Balbalan the country appears favorable for Arabian and Robusta in their respective altitude zones. The Mountain slope from Balbalan to Dauangan includes some very good land that with the proper rainfall would undoubtedly grow Robusta coffee. The stretch from Limus over Taga, Pinucpuc and southward to Gubgub and Tabuk is not suited to coffee. Naneng would appear to be unusually well adapted to Robusta and Excelsa in their respective altitude zones both with respect to soil and rainfall.

The long slope descending from Kadaklan to Natonin and for some distance beyond includes a rather large body of good agricultural land, apparently with a fairly well distributed rainfall, and Robusta may here be recommended. Then there is apparently a dry district on both sides of the Kadaklan River. The land in the district around Damag and toward Bunhian

is gently rolling, fertile and with a fairly well distributed rainfall. Robusta and Excelsa are well worthy of a trial here. From Mayayao over Ducligan and Banaue the arable land is already well under cultivation; the remainder is too poor or too precipitous; Kiangan appears favorable for Robusta. The unsettled region between Kiangan and Payauan is not sufficiently attractive for settlement at present with so much other better and more accessible land. From the observation made in Nueva Vizcaya from Bayombong to Aritao much of this land is well suited to Excelsa and possible also to Robusta.

The soil in the Mountain Province varies from light volcanic ash with greater or less admixture of usually small stones to a light to heavy loam with more or less humus according to the location and character of the vegetation. Heavy clay soils and sandy soils are exceptions, at least along the route of travel. While there are considerable eroded lands too poor or wind swept to be suited to coffee, there are also large areas where coffee would undoubtedly become profitable. Probably one-fourth to one-third of the area consists of cogonales, or land overgrown with weeds or other grasses.

The amount and distribution of the rainfall has a very important bearing on the adaptability of a region to the various coffees. It is therefore exceedingly unfortunate that there are no rainfall records available for examination; if there were the probability of success of the new coffees in the various districts could be determined with a much greater degree for accuracy.

Because of their different character, and different requirements relative to climate, soil and preparation, broadly considered coffee is usually segregated into three groups: (1) Arabian coffee; (2) Robusta, and (3) Liberian coffee.

Arabian coffee is especially adapted to culture on a small scale such as prevails in the Mountain Province and this coffee is therefore worthy of particular attention. It was introduced into the Mountain Province many years ago by the Spaniards, and comparatively speaking, for some years coffee was exported in large quantities. The coffee from the Lepanto subprovince particularly enjoyed the reputation of being of excellent quality.

While no accurate data are available it would appear that coffee production declined steadily during at least the last ten years, probably longer, until in 1913 the coffee crop for the Mountain Province was estimated at ₱42,000 it being then the leading coffee-producing province in the Philippines.

The coffee blight, *Hemilaia vastatrix*, has generally been credited with the responsibility for the decline of the coffee indus-

try, and it was found to be present in every municipality visited. It is of course true that the coffee would have been destroyed by the blight in any event even in the lower altitudes, but is seems probable that in elevations above 800 meters, ignorance on the part of the people of the requirements of the coffee plant, is responsible for the failure of the coffee rather than the blight. In other words, the trees having lacked the proper attention their constitution was weakened and they became easy victims to the disease. The main cultural mistakes were: (1) Entire lack of permanent shade trees, and (2) defective terracing. Unless these mistakes are corrected coffee will never figure prominently among the products of the province. The fact that the Arabian coffee, notwithstanding the unfavorable conditions under which it is grown, still manages to survive and even to produce small crops, seems to substantiate the experience elsewhere that properly managed this coffee would be profitable above an elevation 800 meters up to perhaps 1,500 meters. Below and above these elevations it would be unwise to attempt the culture of Arabian coffee.

Arabian coffee succeeds well with a distinct dry season, and should not be planted where the rains coincide with the flowering season. With good care the average yield is 400 kilos of cleaned coffee per hactare, rising to a maximum production of about 850 kilos.

There are several other coffees which are resistant to the blight and that, other conditions being favorable, may be grown below 800 meters. These are the Robusta, Canephora, Quillou, Uganda, and Congo, all of which are considered to belong to what is generally referred to as the Robusta type of coffee, and the Liberian, Excelsa, and Abeocuta coffee, which are usually included under the Liberian type.

While the probabilities are that these coffees will succeed in various districts it is well to remember that their planting is yet experimental and they are not recommended for extensive culture at present.

Those coffees belonging to the Robusta group may be grown from sea level to an altitude of 1,000 meters with the expectation to be profitable, but the best results are obtained between 450 to 700 meters altitude. They require a permeable soil, volcanic ash or a friable loam of good quality, abundant rainfall evenly distributed throughout the year, and their culture should perhaps not be attempted where the average dry season is of more than three months duration.

The coffee belonging to the Liberian group should be grown

from sea level up to an elevation of 350 meters, except the Excelsa, which may be grown up to an altitude of 700 meters. The coffees belonging to this type will of course succeed on the same soil as the Robusta, but they are especially recommended for heavy, stiff soils, where the dry season is long, and where for these reasons the Robusta coffees would fail.

Both Robusta and Liberian coffee have been introduced into the Mountain Province, but not having been handled properly no results have been obtained from a practical point of view.

Mr. Isidro Moreno, in Comillas Llanos, Cervantes, planted Robusta coffee in 1910, of which some 50 trees now remain which though neglected have made good growth. These trees are about 3 meters high and are this year bearing their third crop of coffee.

A number of Robusta trees growing without shade and otherwise neglected were seen in Lubuagan. A few were also found in Kiangan, being in their fifth year, growing in grass sod without any care whatever, partially shaded by the surrounding trees. Mr. Leonardo Vergara, the owner, reported that last year one of these trees yielded 2 gantas of unhulled coffee, or *a yield of 2,235 gantas per hectare* with proper spacing and a deduction of 15 per cent of the yield to account for nonbearing trees that would occur in field culture. Liberian coffee was noted both in Kiangan, Ifugao, and Imugen, Nueva Vizcaya, but all the trees were in a dying condition.

So far as known all the above-mentioned introductions have been made from seeds obtained of the Bureau of Agriculture, grown at the Lamao Experiment Station.

As already stated on a previous page, after a careful study of the situation, considering also the experience of other countries, the outlook for success appear sufficiently promising to warrant a serious attempt to rehabilitate the culture of the Arabian coffee above an altitude of 800 meters.

The rehabilitation of the Arabian coffee will of course consist principally in the setting out of young plants, but in many places it may be desired to make an attempt to rejuvenate the old trees.

The following method of procedure is recommended in the course of this work:

The old coffee plantations should be thinned out, leaving the most vigorous trees at a distance of 2 to 2.5 meters apart. These trees should be lopped at about 30 centimeters from the ground as are newly budded trees in a nursery. Then, as soon as the sprouts from the stumps are about 30 centimeters long

the lopped part of the tree should be severed from the stump and removed.

In order to prevent the spread of the fungus to the new and renovated coffee plantations *all trees not properly cared for, the trees that are below the Arabian coffee belt, and all prunings and thinnings should be removed and burned as the work proceeds.*

After the thinning is completed, which should preferably be done just before the avent of the rains, shade trees should be planted as soon as the rains arrive. Ipil-Ipil, *Leucaena glauca,* is recommended for permanent shade for general use, but Dapdap, Guango, and various other trees may also be used. The trial of local trees for shade on a small scale is to be recommended.

The permanent shade trees of the Ipil-Ipil should be set out approximately 5 meters apart. Dapdap, *Albizzia moluccana,* and *Deguelia microphylla* for permanent shade should be set out 12 to 15 meters apart, Guango, *Pithecolobium saman,* 15 to 20 meters.

All these shade trees may of course be grown from seed, but Ipil-Ipil, Dapdap and Guango are also readily propagated from cuttings. If they are being propagated from seed, follow the directions in Bulletin No. 32, Bureau of Agriculture, and set out the plants between the coffee when they are about 0.5 to 1 meter high. The seed should be sown 7 to 8 months in advance of the date when it is planned to set out the plants in the field.

If cuttings are used, these should be cut about 1 meter long from branches or stems 2 to 8 centimeters in diameter, and inserted in the ground about 20 centimeters deep where the trees are intended to grow. This is most conveniently done by making the holes with a crowbar. The soil should be well packed around the cuttings from the bottom of the hole to the surface so that they stand firm in the ground on being pulled by hand.

This work should be done at the beginning of the rainy season after the soil is well moistened and during a cloudy or rainy day. If the work is carefully done 85 per cent of the cuttings may be expected to grow.

The permanent shade trees just referred to naturally do not provide sufficient shade for the coffee during the first two to four years. Therefore temporary shade must be planted between these trees and the coffee. This shade may be provided either by setting additional plants or cuttings of the plants

used for permanent shade, between the coffee plants, or it may be provided by the planting of cadios, papayas, castor oil beans, cassava or other local plants that are rapid growth, do not become noxious weeds, and make a heavy growth of leaves for the formation of mulch to cover the ground. While the other above-mentioned plants may be used for temporary shade, the cadios, Ipil-Ipil, and Dapdap, are considered preferable. As the growth of the plants progresses, and the shade becomes excessive, the temporary shade should be gradually thinned out until finally only the permanent trees remain.

When the sprouts from the old coffee-tree stumps have attained a height of about 60 centimeters above the ground all the weak sprouts should be pruned away with a sharp knife, leaving two or three robust shoots to form the new coffee tree; every 6 weeks to two months the trees should then be inspected and all suckers or growths should be pruned out. Thereafter the plants should be treated as on a seedling coffee plantation.

There is scarcely room for doubt but that the failure of the coffee was partly due to faulty terracing, with the resultant erosion. This should be guarded against by constructing the terraces so as to prevent the washing away of surface soil. Aside from keeping the terraces in good condition, the planter should dig small cisterns here and there to catch the rain water; from these it can then seep away in the soil without doing any damage. The practice of planting perennial legumes along the edges of the terraces in the Javanese coffee plantations to prevent erosion is also recommended. The seed is then sown thickly and the plants are cut a few centimeters from the ground, from time to time and serve to provide a good mulch around the trees and to enrich the ground. The Ipil-Ipil is one of the most useful plants for this purpose.

Unless the land is very fertile it is well to keep the vacant land covered with a leguminous cover crop while the plants are young. Several species have already been introduced in Bontoc for this purpose; the cadios may also be used. Unless seed is desired these plants should be cut about 15 to 20 centimeters from the ground whenever they have attained a height of about 1 meter.

Owing to the fact that the Mountain Province is in the typhoon belt, new plantations of coffee should be located where they are well sheltered; soil and rainfall in each locality should also be carefully considered.

The planting of the new coffees is particularly recommended

for selected localities where there are areas of at least 300 hectares suitable to coffee which could be made tributary to a possible central coffee-reduction plant.

In the country traversed trial plantations of the new blight-resistant coffees are especially recommended in the following localities: Cervantes, Tinglayan, the slope between Balbalan and Limus, in Naneng, Natonin, Damag, and Kiangan.

The establishment of small testing and demonstration stations for corn, camotes, ubi, cotton, etc., and a nursery for the propagation of fruits in connection with the coffee trial plantations would be advisable, each demonstration station to be in charge of a resident agricultural inspector, part of whose time should be devoted to traveling demonstration work. While such work might be carried on independently by the provincial authorities it is believed that better and more uniform results would be gained if the agricultural work was directed by one authority.

Data relative to the rainfall are very important in regard to coffee as well as other crops, and it is recommended that arrangements be made with the Director of the Weather Bureau to, if possible, install rain gauges in all municipalities where there is a resident agricultural inspector, and in the other more important municipalities.

The silkworm was introduced into Bontoc some years ago, and climatically there is no reason why sericulture should not be a successful industry in the Mountain Province. However, considering the attention to details required in this industry, it is very doubtful, not to say improbable, that it can be successfully introduced among the native population at this stage of their development. It is believed that funds available for the agricultural development of the Province can be expended to greater advantage in the encouragement of industries other than sericulture.

A large swarm of flying locust encountered between Naneng and Gnipen called my attention to this scourge of not only the Mountain Province but the entire Archipelago, which has assumed such proportions that large expenditures of time and money are annually required to keep it under reasonable control.

The urgent need of the work as conducted at present for the control of the locust in well recognized, but it is desired to call attention to the fact that *all these efforts and expenditures do not contribute anything whatever toward the permanent extermination of the locust plague;* it is a zizyphus-like task that must be renewed one year after another.

It is generally conceded that the cogonales and grasslands are at the root of the locust evil and that the locust problem would cease to exist if there were no cogonales.

The cogonales are the natural consequence of the "caingin system" of cultivation, and when we consider that the same system also entails the gradual destruction of the hardwood forests, and that it is generally admitted that the denudation of the forest is followed by a more arid climate, erosion, with the attendant decline of the fertility of the land, it must be conceded that the caingin system is one of the most serious agricultural evils of the Mountain Province which can not be too strongly condemned.

In defense for the caingin system it is usually contended that it is practiced because of the impoverished condition of the soil after two or three crops have been harvested. Be that as it may elsewhere it is not true of the Mountain Province. Special attention was given to this matter and a luxuriant vegetation was everywhere found on the abandoned land testifying to the fertility of the soil.

Therefore, while the necessity of the present method of controling the locust and the excelence of this method is recognized, it is believed that the locust campaign would be still better organized if it included a method that has in view *the permanent eradication of the locusts.* The suppression of the caingin system, and the reforestation of the cogonales and other grasslands as a part of the locust campaign are strongly recommended for this purpose, in the belief that the benefits will be lasting and without inflicting any unreasonable hardship upon the people.

For the purpose of abolishing the caingin system the enactment of a law or the passing of ordinances is suggested that would make it obligatory for any one to reforest all cultivated land that has been abandoned by him in order to clear and cultivate virgen forest land for agricultural purposes. This work should include not only the planting of the seed, but the subsequent care until a stand beyond the danger of forests fires was established.

For the reduction and, it is hoped, the eventual elimination of the cogonales it is recommended that, in addition to the time each person is now required by the Government to devote to the destruction of locusts during an invasion of these insects, he be also required to contribute a certain amount of labor each year to the reforestation of cogonales. A part of the money

allotted for the destruction of locusts should be diverted annually to the supervision of the work hereabove outlined.

A cheap and effective method of introducing the Ipil-Ipil, concededly the best plant obtainable for reforestation purposes, would be to send a quantity of seeds to the agricultural inspectors in the Mountain Province to be scattered along the roads in the course of their trips of inspection. These plants would already in the second year yield seed for the extension of reforestation work.

SUMMARY OF RECOMMENDATIONS.

To summarize, I recommend that the following measures be taken with a view of improving the economic and agricultural conditions of the Mountain Province:

1. That all work pertaining to agricultural improvement and education be centralized under one authority.

2. That, if possible, arrangements be made with the Director of the Weather Bureau to install rain gauges in all municipalities where there is a resident agricultural inspector and in the other more important municipalities.

3. That small model coffee plantations of the various introduced coffees and of the Arabian coffee be set out in the districts most promising for each of the three coffee types in their respective altitude zones in order to demonstrate the benefits of proper culture, correct terracing and shade, and to ascertain the suitability of the new coffees in the various localities; and that coöperative work be inaugurated to demonstrate the value of rejuvenating the old coffee plantations by the means of thinning, pruning and shading; and to establish nurseries of Arabian coffee for the wholesale distribution of plants in the Arabian coffee zone.

4. That in connection with the coffee demonstration plantations provision be made for the testing of corn, camotes, gabi, cotton, etc.; for the introduction of such new varieties of these and other crops as may be deemed advisable; and for the propagation and dissemination of Philippine and other fruits not yet introduced into or sparsely grown in the Mountain Province.

5. That comparative tests be made of the rice varieties in the province to be followed by systematic breeding work.

6. That a comprehensive education and demonstrative campaign be inaugurated to show the value of crop rotation and better culture in general, including the encouragement of more extensive planting of sesame, mungos, anipay, cowpeas, beans, limas, cassava, gabi, ubi, coconuts, and various fruits.

7. That investigation be started to ascertain the value of cotton, ramie, maguey, roselle, and jute for the purposes indicated in this report.

8. That steps be taken to facilitate the exportation of live stock to the lowlands, and that grade boars be stationed at the more important sections for the improvement of the hogs.

9. That means be considered for the permanent eradication of the locust, by the suppression of the "caingin" system of culture and the gradual reforestation of the cogonales and other grass lands, which recommendations might be considered for the entire Archipelago.

10. That if the preceding recommendations are favorably considered the authority for the enforcement of such regulations as it may be deemed advisable to adopt with a view of carrying it into operation be vested in the Director of Forestry.

FIBER DIVISION.

The Government fiber inspectors, during the year 1917, inspected, stamped, and approved 1,291,851 bales of abacá (Manila hemp), and 113,579 bales of maguey and sisal, and also 1,553 bales of pacol and canton.

There were produced a total of all fibers during the year 1917, 1,406,983 bales, an increase over the total of the previous year of 101,831 bales.

General remarks.—The year 1917 has been a very favorable year for the fiber industries, in so far as weather conditions are concerned. No typhoons nor floods of any serious character have visited the fiber provinces during the year, and the abacá plantations in the Southern Luzon provinces are reported to have fully recovered from the effects of the typhoons of 1915. This condition, it is believed, is conducive to still further material increase in the production of abacá and maguey throughout the Archipelago.

The most notable change in the abacá production during 1917 was the great increase of the good and excellently cleaned grades and a corresponding decrease in the production of the coarse and Daet grades. This improvement was the direct result of the work of our educational inspectors throughout the abacá producing districts in their effort to educate the producers to improve the method of stripping in order to procure the very satisfactory prices being paid for the excellent and well-cleaned grades.

The price obtainable on the local market for abacá and maguey fiber throughout the year 1917 was most satisfactory. In fact, during a great period of the year 1917, the market price of abacá fiber reached a maximum never before obtainable in the Philippines.

During the latter part of the year 1917, the Bureau of Agriculture received the Prieto maguey extracting machines, which were ordered in the early part of the year, and immediately had them installed at Singalong Experiment Station and began experimenting with the view of adjusting these machines to the adaptability of stripping Philippine maguey. The results obtained were very satisfactory and it is believed by the under-

signed that these machines will give perfect satisfaction and greatly increase the maguey industry throughout the Philippine Islands, and put it on a more staple basis.

Coöperation of the United States Department of Agriculture in Fiber Investigations.—During the previous fiscal year tentative arrangements were made by the chief of the fiber division, in conference with officials of the United States Department of Agriculture, for coöperative work in promoting the interests of the binder-twine-fiber industry in the Philippine Islands. Appropriations covering the cost of this work were subsequently obtained, and in June, 1917, a specialist in fiber-plant production was detailed by the United States Department of Agriculture for duty in the Philippine Islands.

The development of our maguey and sisal industries, both by increasing the production and by improving the quality of these fibers, is a matter of vital interest to the farmers in the maguey-producing provinces. As a result of the increased demand on the part of American farmers for binder twine, due in part to war conditions, together with the existing high prices and the possibility of world's shortage of binder-twine fiber in these Islands, the maguey and sisal fibers have attracted considerable attention in the United States.

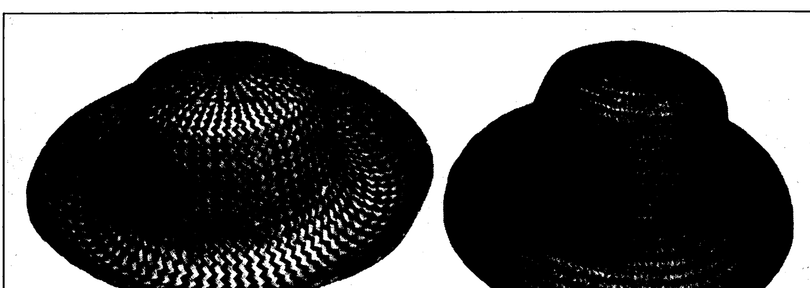
The purpose of this coöperative work is to facilitate, by reason of increased funds and personnel, the continuance of work already organized by the Bureau of Agriculture and the extension of this work along such lines as may seem desirable.

The coöperative work that has been carried on during the latter part of the current year has included investigational and publicity work in the maguey provinces, and the testing of fiber-cleaning machines at the Singalong Station in the city of Manila.

Status of industry.—Statistics show that the production of maguey fiber for export from the Philippine Islands commenced in the year 1904, when the quantity of fiber exported was only 690 metric tons, valued at ₱156,242. Between the years 1905 and 1915, inclusive, the quantity exported varied between 2,000 and 7,000 metric tons, and the value between ₱326,546 and ₱1,181,902, the highest figures being for those of the year 1913. Last year, 15,686 metric tons were exported, valued at ₱3,493,142. This phenomenal increase of production during 1916, is due to the material improvement in the preparation and grading of the fibers, as a result of the application of the fiber inspection and grading law, and by the considerable rise in price of all cordage fibers, on account of the European war.

Again, this increase in the quantity and value of maguey pro-

(*a*) Native methods of stripping abaca. First and second processes. (Silang, Cavite.)



(*b*) Tagal braid hats. Tagal braid is made from the abaca fiber and is becoming quite an industry in Japan and the Philippines.

duction has aroused considerable interest in this fiber throughout the Philippine Islands. A large number of requests for maguey and sisal plants had been received by this division during the year both from old and prospective producers. All these requests have ben complied with by furnishing suckers and bulbils from the plants we have at La Carlota.

Practically the entire quantity of maguey is still being produced by the retting method, and this office fully realizes that during normal years such a product cannot compete on favorable terms with the Henequen or the sisal of German East Africa, Mexico, and Java, all of which are cleaned by machinery.

On this account, an effort has been made by this division to obtain funds from the Philippine Legislature, in order to purchase stripping machines and operate same for demonstration purposes. This year an appropriation was made available and two Prieto stripping machines were brought from Prieto Machine Company, New York. They are at present temporarily installed at Singalong Experiment Station, under the supervision of the mechanic and superintendent of repair shops of this Bureau.

These two machines are made to operate from time to time for the purpose of demonstration. After a series of demonstrations, one will be sent to Ilocos district and the other to Cebu, where extensive cultivation of maguey and sisal is carried on.

Experimental work and distribution of plant material.—The fiber division carried forward experimental work and distributed plant material during the year 1917 of the following varieties of fiber plants: Abacá, agave, kapok, cotton, roselle, Panama-hat palm, and ramie or China grass.

IRRIGATION IN THE PHILIPPINES.

[By C. E. GORDON, *Assistant Chief Engineer, Bureau of Public Works.*]

A discussion of irrigation and the agricultural possibilities accruing from properly administered irrigation is timely. Because of the war, and the withdrawal of labor from agriculture, a decrease in the production of foodstuffs has developed. While agricultural workers have not been withdrawn from these Islands, the effect of decreased production is evident throughout the Archipelago in higher prices and lower supply. As these Islands have been obliged to import large quantities of foodstuffs for decades from lands which are contributing directly to the food necessities of war, it follows, clearly, why the present high prices and decreased quantity of food obtains.

Properly developed irrigation increases food production. This increase may be either in an increase in the number of crops grown, or in the quantity of produce of each crop grown. An increase in the number of crops grown is amply illustrated by the results obtained in the operation of the system constructed in the Provinces of Bulacan, Cavite, and Laguna by the friars. An illustration of the increase in the returns, per crop, may be had in examining the production records under the Pilar Irrigation Project constructed by the Insular Government in the Province of Bataan, and in the returns from adjoining, but similar, land for the same period. Even during the regular rice-growing season, the rice grown under conditions permitting it to be watered at any time when needed produced much largers returns than the adjoining rice that was more or less affected by being entirely dependent upon the rainfall. Apparently, there were times when this latter rice suffered from drought, causing a decrease in development. Under irrigation no loss in development is possible because of lack of moisture. Another illustration may be taken from the agricultural methods of sugar cane growing on the large estates of Calamba and San Josè. Upon those estates irrigation has been developed, and apparently the objective of the operators is to be able to irrigate every part of the estate devoted to the growing of cane.

The question arises, why do these cane growers go to the considerable expense of preparing their estates for irrigation? These irrigation systems certainly cost a considerable sum. Capital, usually, is not expended unless for a profit. As the capital invested in these estates come largely from those who have had more or less sugar-producing experience in other lands, these investors knew that the money expended by them, in the past, for the irrigation of their cane paid, and they knew, consequently, that the development of cane in these Islands by irrigation would also pay. Unless the rainfall is just right, the maximum development of sugar cane is possible only by means of proper irrigation. If the small hacendero is to obtain maximum returns from his cane, he must irrigate. Therefore, he should look about his hacienda and ascertain if there is a near-by stream, the waters of which are sufficient in amount and in constancy of flow, and the use of which is feasible. If such a natural resource be found, he should proceed at once to develop the use of the waters either through private or public initiative. If the millionaire hacenderos find that irrigation pays, the moderate or small hacenderos will also find that it will pay.

Water is a natural resource. Irrigation, even by a private entity, possesses right based upon its general acceptance as a public benefit. Throughout the enlightened world, the use of water for irrigation is given eminent domain procedure upon the theory that the public is benefited. Water being a natural resource, it should be studied and controlled by the State, also coal, the metals, and other inorganic products. The State should examine carefully and minutely its natural resources, and the result of the efforts should be placed before its citizenship for exploitation. Natural resources are of no benefit unless they be utilized. The unknown gold mines are worthless. The unknown coal fields are worthless and will remain so far all time unless discovered and used. The waters of the streams, except for their domestic uses and navigation or floatation, is of no worth whatever unless utilized. Therefore, governments, have their resources studied, these studies cost large sums, they are quietly announced, and the results are published for distribution for the benefit of the investors. This is what the State must accomplish here. It must have the streams studied properly and constantly. The run off of these streams must be known through a consecutive series of years. The knowledge must be published in book form for the public use. Then, and not till then, will the State be in a position to properly utilize its run-off waters for irrigation. With such knowledge, the

irrigation question becomes one that may be solved with facility. Land will require a certain amount of water per unit area. The unit here is the hectare. The amount of water required per hectare varies from 1 to 3 liters per second. This variation is due to the porosity of the soil. Close-grained clay soil not require more than 1 second-liter, but loose sandy soil will require easily 3 second-liters. A second-liter is a stream flowing 1 cubic liter in 1 second of time. With a stream of a definitely known cubic-liters-per-second flowage, and having an approximate knowledge of the texture of the soil, the approximate area of land that may be irrigated becomes simply an example in long division. Knowing the amount of land that the water of the stream will irrigate, and the cost of the proposed works, the feasibility of practicableness of the proposition again becomes a simple problem of long division. Therefore, it will be evident that irrigation from an engineering viewpoint is a very simple matter *if the data are available.*

Irrigation is popular where it is practiced. In the British Empire it is practiced in India, Australia, Western Canada, and Egypt; in the French possessions it is practiced in Algeria, and Indo-China; in the Ducth possessions it is practiced in Java; it is practiced in Western America and Hawaii; it is practiced in Mexico, Perú, Argentina, Italy, Spain, Japan, China, and Russia. If irrigation be so general, why should its development here be dormant? If the great nations of the world find it profitable to develop their agriculture by irigation, this Government should likewise find it profitable.

A rapid development by irrigation here is not properly possible. Such a development will be possible only when the necessary data have been secured. In India and Java the run-off of a stream for several consecutive years is deemed to be an essential preliminary to serious development consideration. Maximum and minimum flows are the critical periods of irrigation streams. The floods, unless approximately known, will take out the barage, and render an irrigation project useless unless sufficient provision for taking care of the flood discharge has been provided for. Unless the flood volume is approximately known the engineer must guess it. If he guesses wrong, the barrage will be carried away with the first large flood. Therefore, unless data is obtained conditions governing irrigation structures must be guessed at. The other critical period of a stream is the driest period. This is critical for the reason that it limits the irrigable area.

Native process of irrigation. (Hand-power wooden pump.)

The irrigation possibilities of these Islands are considerable. The waters which are now being allowed to go to waste should be utilized. Of course the area irrigated will be but a small percentage of the total area of the tillable portion of the Archipelago. This is so in all countries where irrigation is provided; but, this small percentage will comprise hundreds of thousands of hectares.

The writer has endeavored to indicate the great necessity of data for successful irrigation. To obtain it will require time and funds, but it will be far cheaper than to construct a project at a cost of millions and have the dam taken away with the first flood rendering the expenditure of the millions useless; or to construct an expensive project and find that the available water is insufficient, or already in private ownership through concession or prescription.

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STATISTICS ON PRINCIPAL CROPS.

The following tables of crop statistics may be of benefit to those desirous of having reliable information on agricultural conditions in the Philippines on nine of the leading productions:

Crop statistics for the Philippine Islands year ending June 30, 1918.

EQUIVALENTS USED IN THE FOLLOWING TABLES.

1 hectare equals 2.471 acres (English).
1 hectare equals 3577 brazas cuadradas or 35.77 loanes or 3.577 balitas or 0.3577 quiñon (Spanish).
1 quintal equals 46 kilos or 100 Spanish pounds.
1 kilo equals 2.20462 English pounds or 2.174 Spanish pounds.
1 kilo equals 2.2462 avoirdupois pounds.
1 metric ton equals 1000 kilos.
1 picul equals 63.25 kilos.
1 cavan equals 75 liters or 0.75 hectoliters or 2.128275 bushels.
1 cavan of rough rice (palay) averages 43 kilos in weight and cleans at about 65.12 per cent producing an average of 28 kilos of cleaned rice (arroz).
1 cavan of cleaned rice (arroz) averages 57.5 kilos in weight.
1 cavan of corn on cob averages 30 kilos in weight and shells at about 79 per cent producing an average of 23.77 kilos of shelled corn.
1 cavan of shelled corn averages 58.5 kilos in weight.
2.05357 cavans of palay (average) produce 1 cavan of arroz.
1 hectoliter equals 2.8377 bushels.
1 liter equals 0.908077 dry quart or 0.28377 bushel.
1 liter of palay averages $0.57\frac{1}{3}$ kilo in weight.
1 liter of arroz averages $0.76\frac{2}{3}$ kilo in weight.
1 liter of shelled corn averages 0.78 kilo in weight.
1 liter equals 1.0567 liquid quarts or 0.26417 gallon (English measure).
1 liter of coconut oil weighs 0.925 kilo.
2.46835443 cavans of corn on cob (average) produce one cavan of shelled corn.
200 ears of corn is the average number which will fill one cavan of corn on cob.
0.15 kilo is the average weight of one ear of corn.
1 arroba equals 11.5 kilos.
1 liter equals 0.4 kilo or 400 grams or 0.0625 arroba (Spanish liquid measure).
₱1 (Philippine currency) equals $0.50 (United States currency).

ROUGH RICE (PALAY).

Rank.	Province.	Area cultivated.	Amount produced.		Average production per hectare.		Average price in the municipal markets.		Total value in the municipal markets.
		Hectares.	Liters.	Cavans.	Liters.	Cavans.	Per liter.	Per cavan.	
26	Abra	9,402	20,186,882	269,158.42	2,147	28.62	₱0.042	₱3.15	₱850,063.13
39	Agusan	1,463	2,501,975	33,359.66	1,710	22.80	.051	3.82	130,091.88
14	Albay	24,426	43,267,685	576,902.46	1,362	18.16	.038	2.87	1,657,100.03
18	Ambos Camarines	27,204	40,210,550	536,140.66	1,478	19.70	.047	3.55	1,907,606.40
23	Antique	27,388	34,420,605	458,941.40	1,257	16.76	.036	2.70	1,246,518.70
29	Bataan	7,020	16,490,612	219,874.83	2,349	31.32	.045	3.37	744,427.83
43	Batanes	56	37,220	496.27	665	8.86	.037	2.77	1,400.15
16	Batangas	34,854	42,240,237	563,203.16	1,211	16.15	.044	3.30	1,886,207.73
17	Bohol	26,223	41,656,565	555,420.87	1,588	21.08	.042	3.15	1,784,169.16
42	Bukidnon	85	193,900	2,585.33	2,280	30.40	.050	3.75	9,695.00
4	Bulacan	54,421	116,566,080	1,554,214.40	2,142	28.56	.039	2.91	4,523,864.83
22	Cagayan	19,814	36,398,027	485,307.03	1,837	24.49	.048	3.60	1,484,908.93
6	Capiz	54,927	104,548,892	1,393,985.23	1,903	25.37	.034	2.54	3,536,740.00
9	Cavite	29,783	61,821,686	824,289.15	2,076	27.68	.037	2.77	2,356,955.23
34	Cebu	4,659	6,745,481	89,939.75	1,448	19.31	.046	3.45	300,851.57
41	Cotabato	896	1,393,900	18,585.33	1,555	20.73	.040	3.00	55,756.00
33	Davao	7,711	7,849,670	104,662.27	1,017	13.56	.056	4.20	444,615.70
8	Ilocos Norte	56,243	94,009,721	1,253,462.95	1,671	22.28	.037	2.77	3,534,874.62
21	Ilocos Sur	30,445	37,622,982	501,639.76	1,106	14.75	.047	3.52	1,792,550.93
3	Iloilo	102,885	160,539,468	2,140,526.24	1,550	20.67	.035	2.61	5,598,646.49
40	Isabela	2,262	2,361,050	31,480.67	1,044	13.92	.040	3.00	94,566.34
20	Laguna	24,074	38,761,195	516,815.93	1,610	21.47	.046	3.45	1,807,232.00
38	Lanao	3,305	4,573,000	60,973.33	1,383	18.44	.046	3.45	214,060.00
10	La Union	34,650	60,450,820	806,010.93	1,744	23.25	.042	3.15	2,552,200.99
12	Leyte	35,813	50,708,957	676,119.43	1,410	18.80	.047	3.52	2,420,052.04
30	Mindoro	7,790	12,869,817	171,597.56	1,652	22.03	.032	2.40	422,434.44
36	Misamis	4,345	6,079,945	81,065.93	1,399	18.65	.059	4.42	362,254.90
24	Mountain	26,558	29,470,371	392,938.28	1,109	14.79	.051	3.82	1,516,148.15
2	Nueva Ecija	109,317	279,184,254	3,722,456.72	2,554	34.05	.029	2.15	8,012,919.12
31	Nueva Vizcaya	6,149	10,978,670	146,382.27	1,785	23.80	.042	3.15	470,401.80
11	Occidental Negros	32,036	58,825,812	784,344.16	1,836	24.48	.041	3.07	2,458,247.15
37	Oriental Negros	4,748	4,963,496	66,179.95	1,045	13.93	.042	3.15	212,724.70
32	Palawan	6,092	8,392,826	111,904.35	1,377	18.36	.045	3.37	388,026.80
5	Pampanga	58,782	106,662,688	1,422,169.17	1,815	24.20	.039	2.92	4,163,718.64
1	Pangasinan	151,626	282,136,717	3,761,822.89	1,861	24.81	.038	2.86	10,771,433.19
13	Rizal	29,510	48,814,483	650,859.77	1,654	22.05	.041	3.07	2,034,372.54

25	Samar	15,567	21,334,274	284,456.99	1,370	18.27	.047	3.52	1,020,213.26
28	Sorsogon	13,329	17,036,129	227,148.39	1,278	17.04	.040	3.00	797,594.52
44	Sulu								
27	Surigao	13,804	19,932,211	265,762.81	1,444	19.20	.040	3.00	806,587.40
7	Tarlac	63,765	99,356,900	1,324,758.67	1,558	20.77	.035	2.62	3,486,526.30
15	Tayabas	34,262	42,936,689	572,489.19	1,253	16.71	.042	3.15	1,818,556.31
19	Zambales	24,353	39,530,775	527,077.00	1,623	21.63	.037	2.77	1,463,293.54
35	Zamboanga	3,650	6,690,550	89,207.33	1,833	24.44	.035	2.62	237,203.27
	Total	1,225,692	2,120,753,767	28,276,716.89					81,377,811.71
	General Average for the Philippine Islands				1,730	23.07	.038	2.85	

ABACA (MANILA HEMP).

Rank.	Province.	Area.		Amount produced.		Average production per hectare.		Average price in the municipal markets.		Total value in the municipal markets.
		Cultivated.	Harvested.	Kilos.	Piculs.	Kilos.	Piculs.	Per kilo.	Per picul.	
		Hectares.	*Hectares.*							
	Abra									
17	Agusan	2,065	1,770	747,632	11,820.27	422	6.672	₱0.55	₱34.78	₱411,328.14
2	Albay	97,127	67,385	26,424,985	417,786.33	392	6.197	.2889	18.27	7,637,100.04
4	Ambos Camarines	69,848	47,311	19,230,292	304,036.24	406	6.419	.2226	14.07	4,271,194.79
22	Antique	1,133	517	216,778	3,427.32	419	6.629	.4035	25.52	87,475.01
	Bataan									
	Batanes									
21	Batangas	886	600	267,993	4,237.04	447	7.067	.4231	26.76	113,387.75
18	Bohol	1,445	897	386,695	6,113.75	431	6.814	.344	21.75	133,132.34
	Bukidnon	50								
	Bulacan									
	Cagayan									
14	Capiz	6,405	4,673	1,725,806	27,285.47	369	5.834	.4326	27.36	746,788.00
10	Cavite	9,289	5,544	2,189,057	34,609.60	395	6.245	.614	38.84	1,343,159.00
12	Cebu	8,109	4,576	1,959,188	30,975.30	428	6.767	.4376	27.68	857,142.34
24	Cotabato	2	1	315	4.98	315	4.980	.31	19.70	97.65
6	Davao	13,642	9,158	7,573,543	119,739.81	827	13.075	.5691	35.99	4,310,231.53
	Ilocos Norte									
	Ilocos Sur									
19	Iloilo	1,551	973	336,873	5,326.05	346	5.470	.4843	30.63	163,265.10
	Isabela									
11	Laguna	6,658	5,532	2,151,583	34,017.12	389	6.150	.6972	44.09	1,500,151.79
23	Lanao	350	259	98,289	1,553.98	379	5.992	.24	15.18	23,606.80
	La Union									
1	Leyte	81,862	58,999	35,536,190	561,837.00	602	9.518	.41	25.93	14,691,279.39
15	Mindoro	4,542	3,493	1,685,979	26,655.79	483	7.636	.5125	32.41	864,050.55
7	Misamis	12,097	11,142	5,850,816	92,503.02	525	8.300	.3326	21.03	1,946,160.22
	Mountain									
	Nueva Ecija									
	Nueva Vizcaya									
20	Occidental Negros	2,458	1,220	312,847	4,946.20	255	4.032	.4525	28.62	141,580.27
9	Oriental Negros	9,628	6,505	2,692,093	42,562.73	414	6.545	.22	13.92	592,448.96
	Palawan									
	Pampanga									
	Pangasinan									
	Rizal									

5	Samar	47,108	28,481	17,418,456	275,390.61	612	9.676	.4581	28.97	7,981,058.91
3	Sorsogon	84,683	64,403	25,128,934	397,295.40	390	6.116	.49	30.99	12,318,177.55
	Sulu									
8	Surigao	17,486	11,707	5,553,734	87,806.07	474	7.494	.4255	26.91	2,363,303.45
	Tarlac									
16	Tayabas	5,611	3,404	1,534,476	24,260.49	451	7.127	.39	24.67	600,436.40
	Zambales									
13	Zamboanga	4,465	3,207	1,930,801	30,526.50	602	9.518	.2597	16.42	501,580.51
	Total	488,500	341,765	160,953,355	2,544,717.07					63,598,136.49
	General average for the Philippine Islands					471	7.447	.3951	24.99	

SUGAR CANE.

Rank.	Province.	Area cultivated.	Products derived from sugar cane.					
			Crude sugar.		Panocha.		Basi.	Molasses.
			Kilos.	Piculs.	Kilos.	Piculs.		
		Hectares.					*Liters.*	*Liters.*
31	Abra	341	18,330	289.80	326,562	5,163.04	325,371	12,775
40	Agusan	26	1,000	15.81	17,000	268.77		
27	Albay	474			373,344	5,902.67	38,606	334
24	Ambos Camarines	920	29,286	463.02	1,081,877	17,104.77	1,109	6,718
15	Antique	2,797	4,368,233	69,062.97	23,815	376.52		
25	Bataan	788	1,232,995	19,493.99	14,500	229.25		
37	Batanes	60					90,015	
4	Batangas	16,822	30,422,222	480,983.75				
20	Bohol	1,149	1,007,300	15,925.69	466,912	7,382.01		
43	Bukidnon							
9	Bulacan	4,873	8,684,217	137,299.87			4,743	
32	Cagayan	294			34,756	549.50	175,034	26,870
13	Capiz	3,032	5,519,787	87,269.36	625,392	9,887.62		
12	Cavite	3,527	4,089,101	64,649.82	2,067,004	32,679.91		
6	Cebu	6,963	11,218,228	177,363.29	991,967	15,683.27		
42	Cotabato	19			4,600	72.73	10,000	500
41	Davao	21					14,440	120
14	Ilocos Norte	3,008	91,006	1,438.83	1,529,914	24,188.36	4,707,660	1,153,365
7	Ilocos Sur	5,538	7,911,141	125,077.33	3,148,704	49,781.88	688,532	170,061
3	Iloilo	14,784	29,960,823	473,688.90				
35	Isabela	119			25,350	400.79	33,590	23,640
8	Laguna	4,970	10,091,500	159,549.41	1,667,008	26,355.86		41,250
39	Lanao	31	10,160	160.63	38,440	607.75	1,800	
17	La Union	2,710	2,519,456	39,833.30	1,693,881	26,780.73	291,518	400
11	Leyte	3,538	4,757,695	75,220.47	1,948,608	30,808.03	80	100
21	Mindoro	1,113	3,494,068	55,242.18	13,032	206.04		159,840
36	Misamis	75	58,953	932.06	30,810	487.11		
29	Mountain	419	168,384	2,662.20	82,494	1,304.25	31,751	39,798
18	Nueva Ecija	1,945	3,019,713	47,742.50	513,290	8,115.26	45,860	20,550
33	Nueva Vizcaya	147	7,396	116.93	147,408	2,330.56	23,089	900
1	Occidental Negros	55,263	145,593,997	2,301,881.38				
16	Oriental Negros	2,956	7,278,406	115,073.61	223,913	3,540.13		
88	Palawan	60			41,550	656.92		
2	Pampanga	30,804	61,598,041	973,882.07	1,076,663	17,022.34		
10	Pangasinan	3,633	2,930,900	46,338.34	387,246	6,122.47	152,793	248,147

19	Rizal	1,838	2,350,920	37,168.69	952,814	15,064.25	175,500	17,954
23	Samar	967	49,400	781.03	752,775	11,901.58	2,411	10,065
26	Sorsogon	784	3,130	49.49	662,384	10,472.47		549
44	Sulu							
34	Surigao	123			120,135	1,899.37		
5	Tarlac	7,113	13,376,576	211,487.37	942,647	14,903.51	116,900	6,400
22	Tayabas	1,101	276,770	4.375.81	816,486	12,908.87		7,027
28	Zambales	453	194,600	3,076.68	374,045	5,913.75	86,040	22,133
30	Zamboanga	378	4,350	68.77	243,420	3,848.54		
	Total	185,931	362,338,084	5,728,665.35	23,460,746	370,920.88	7,016,842	1,969,496
	General average for the Philippine Islands							

Rank	Province.	Average price in the municipal markets.				Value in the municipal markets.				Total value.
		Crude sugar per kilo.	Panocha per kilo.	Basi per liter.	Molasses per liter.	Crude sugar.	Panocha.	Basi.	Molasses.	
31	Abra	₱0.0482	₱0.0562	₱0.0652	₱0.0871	₱883.95	₱18,359.59	₱21,219.11	₱1,112.62	₱41,575.27
40	Agusan	.20	.20			200.00	3,400.00			3,600.00
27	Albay		.06		.10		26,102.38		33.40	26,135.78
24	Ambos Camarines	.05	.082	.064	.155	1,464.30	88,705.03	71.32	1,043.60	91,284.25
15	Antique	.077	.076			337,699.96	1,821.20			339,521.16
25	Bataan	.11	.10			137,571.27	1,450.00			139,021.27
37	Batanes			.057				5,207.43		5,207.43
4	Batangas	.09				2,749,410.91				2,749,410.91
20	Bohol	.072	.096			72,570.70	45,127.51			117,698.21
43	Bukidnon									
9	Bulacan	.099		.05		867,622.36		237.15		867,859.51
32	Cagayan		.149	.10	.168		5,183.22	17,656.46	4,526.50	27,366.18
13	Capiz	.091	.072			503,879.25	43,957.24			547,836.49
12	Cavite	.123	.14			514,293.51	292,193.87			806,487.38
6	Cebu	.0971	.0996			1,089,797.41	98,814.13			1,188,611.54
42	Cotabato		.08	.05	.20		368.00	500.00	100.00	968.00
41	Davao			.079	.10			1,142.00	12.00	1,154.00
14	Ilocos Norte	.10	.106	.087	.105	9,100.60	156,991.24	404,097.10	87,503.90	657,692.84
7	Ilocos Sur	.0625	.0666	.0671	.0732	494,279.47	209,918.50	46,199.58	12,553.46	762,951.01
3	Iloilo	.086				2,630,470.78				2,630,470.78
35	Isabela		.11	.08	.09		2,670.20	2,761.70	2,259.00	7,690.90
8	Laguna	.138	.095		.064	1,336,025.00	159,780.31		2,645.00	1,498,450.31
39	Lanao	.14	.13	.05		1,516.00	5,066.00	90.00		6,672.00
17	La Union	.133	.078	.104	.15	304,013.35	126,239.41	31,339.85	60.00	461,652.61
11	Leyte	.1199	.1184	.04	.04	570,729.98	230,739.74	3.20	4.00	801,476.92
21	Mindoro	.279	.261		.02	978,046.54	3,402.00		3,196.80	984,645.34
36	Misamis	.095	.087			5,653.24	2,693.40			8,346.64
29	Mountain	.136	.087	.15	.076	22,971.80	7,240.96	4,768.90	3,057.80	38,039.46
18	Nueva Ecija	.149	.129	.074	.038	551,889.48	66,478.80	3,398.40	783.00	622,549.68
33	Nueva Vizcaya	.243	.18	.137	.50	1,787.60	26,328.10	3,167.21	4.50	31,287.41
1	Occidental Negros	.097				14,162,758.03				14,162,758.03
16	Oriental Negros	.12	.10			876,566.34	23,397.66			899,964.00
38	Palawan		.10				4,155.00			4,155.00
2	Pampanga	.091	.099			5,601,001.12	107,104.56			5,708,105.68
10	Pangasinan	.088	.0767	.173	.144	258,442.29	29,735.51	26,571.55	35,631.35	350,380.70

19	Rizal	.087	.117	.10	.082	204,305.10	111,503.40	17,550.00	1,486.32	334,844.82
23	Samar	.158	.159	.10	.201	7,810.00	120,072.58	241.10	2,003.25	130,126.93
26	Sorsogon	.15	.13		.15	488.40	89,120.54		83.71	89,692.65
44	Sulu									
34	Surigao		.119				14,316.60			14,316.60
5	Tarlac	.082	.10	.069	.142	1,153,056.44	95,170.11	8,170.00	910.00	1,257,306.55
22	Tayabas	.198	.140		.112	54,987.33	115,050.51		791.40	170,829.24
28	Zambales	.118	.123	.10	.10	23,114.00	46,192.01	8,604.00	2,213.30	80,123.31
30	Zamboanga	.14	.10			642.00	35,799.00			36,441.00
	Total					35,525,048.51	2,414,648.31	602,996.06	162,014.91	38,704.707.79
	General average for the Philippine Islands	.098	.103	.086	.082					

NOTE.—In the above table "Crude Sugar" includes sugar in pilones (bell-shaped earthen pots), sugar in bayones (sacks) and sugar in bulk.

"Panochas" are small cakes of unrefined sugar ranging from one-half kilo to one kilo in weight and are the favorite form of handling sugar for local consumption.

"Basi" is a beverage produced from the juice of the freshly cut sugar cane stalks.

COCONUTS.

Rank.	Province.	Trees.		Nuts.		Copra produced.	Oil produced.	Tuba produced.
		Planted.	Bearing (estimated).	Gathered.	Consumed for food.			
						Kilos.	*Liters.*	*Liters.*
40	Abra	3,918	2,184	21,047	12,099	196	815	
18	Agusan	504,863	167,555	6,104,283	42,030	1,515,131	173	
4	Albay	7,014,034	3,304,147	79,607,530	6,886,850	15,587,139	464,743	2,061,081
12	Ambos Camarines	2,191,076	1,071,714	24,968,322	5,455,714	4,256,454	67,910	393,936
23	Antique	335,510	141,312	1,476,866	149,938	300,077	5,626	511,739
37	Bataan	20,294	6,481	35,683	35,683			
34	Batanes	25,487	10,484	61,890	40,482	3,807	1,738	
19	Batangas	360,627	147,744	3,327,362	385,462	676,097		
10	Bohol	2,096,033	1,097,366	35,649,372	1,863,601	8,360,569	73,467	3,291,395
43	Bukidnon							
38	Bulacan	19,203	3,470	22,430	22,430			
29	Cagayan	74,330	31,821	422,026	410,766		1,126	
8	Capiz	3,190,743	1,712,768	44,516,331	1,299,955	10,528,594	58,111	863,489
26	Cavite	111,964	42,660	1,013,391	756,391	81,750		
7	Cebu	4,299,405	2,029,831	44,763,687	7,082,576	7,970,594	250,300	9,887,420
28	Cotabato	59,572	24,600	734,580	76,300	136,597	390	
22	Davao	744,371	357,317	2,871,851	197,137	492,671	5,800	
32	Ilocos Norte	52,110	12,143	170,872	170,872			
30	Ilocos Sur	85,821	70,885	318,167	192,837	25,000	2,533	
17	Iloilo	1,006,659	583,760	7,663,128	2,169,482	1,211,514	29,599	8,515,951
39	Isabela	2,442	1,283	21,164	12,601	57	833	63
2	Laguna	5,065,772	3,395,083	100,921,681	6,883,415	18,204,849	1,050,266	2,291,108
25	Lanao	74,667	41,725	1,335,506	361,300	179,089	26,700	
24	La Union	178,272	79,246	1,468,070	687,653	152,071	17,818	
9	Leyte	2,649,770	1,418,057	40,070,776	8,330,336	7,081,429	135,350	5,615,213
21	Mindoro	808,746	336,258	3,125,290	522,493	599,433	474	143,980
5	Misamis	4,764,683	1,919,573	71,500,198	703,734	16,577,489	17,753	1,486,705
33	Mountain	17,108	9,449	68,263	36,307	3,828	1,542	125
35	Nueva Ecija	33,677	6,113	47,933	44,513		342	
41	Nueva Vizcaya	4,579	1,851	13,606	9,799		335	
16	Occidental Negros	890,566	539,324	9,110,741	1,307,322	1,929,272	6,873	2,088,597
13	Oriental Negros	1,472,467	770,610	24,616,560	594,710	5,498,665	2,872	995,240
20	Palawan	320,965	138,210	3,211,576	484,313	637,445	2,720	455,875
44	Pampanga							
15	Pangasinan	922,900	494,487	9,681,632	2,682,736	1,713,739	122,285	
42	Rizal	13,093	100	260	260			
6	Samar	3,896,510	2,102,276	49,122,464	5,363,140	10,416,134	9,526	3,414,437

11	Sorsogon	1,771,825	885,197	27,707,736	2,665,399	6,186,258	14,702	365,948
36	Sulu	4,005	1,541	38,432	2,300	9,033		
14	Surigao	705,816	371,141	12,342,078	244,227	2,597,828	2,108	678,533
31	Tarlac	43,658	21,687	252,333	225,020		2,331	
1	Tayabas	10,842,497	5,397,303	174,470,338	4,869,138	39,630,420	240,819	597,485
27	Zambales	214,130	94,521	939,322	511,661	91,815	4,586	10,225
3	Zamboanga	3,349,879	2,122,197	96,774,029	793,510	23,855,918	1,121	6,042
	Total	60,244,047	30,965,474	880,588,806	64,586,492	186,510,962	2,623,687	43,674,587
	General average for the Philippine Islands							

Rank.	Province.	Average price per unit in the municipal markets.				Total value of coconut products in the municipal markets.				Total values.
		Per nut.	Copra per kilo.	Oil per liter.	Tuba per liter.	Nuts.	Copra.	Oil.	Tuba.	
40	Abra	₱0.1706	₱0.35	₱0.63		₱2,064.30	₱68.60	₱512.45		₱2,645.35
18	Agusan	.0259	.1547	.25		1,090.90	234,471.47	43.25		235,605.62
4	Albay	.0294	.1526	.3475	₱0.0248	202,786.26	2,378,929.42	161,538.59	₱51,296.94	2,794,551.21
12	Ambos Camarines	.0408	.1397	.2409	.0126	220,809.57	594,746.94	16,363.72	4,962.45	838,882.68
23	Antique	.0380	.1111	.3984	.0717	5,764.72	33,564.14	2,242.01	36,691.65	78,262.52
37	Bataan	.0835				2,978.03				2,978.03
34	Batanes	.0562	.07	.25		2,274.37	266.49	434.50		2,975.36
19	Batangas	.0483	.1884			18,503.77	127,380.40			145,884.17
10	Bohol	.0302	.1492	.2902	.0427	56,255.67	1,247,380.32	21,325.21	140,498.21	1,465,459.41
43	Bukidnon									
38	Bulacan	.0916				2,054.55				2,054.55
29	Cagayan	.0382		.35		15,696.61		394.10		16,090.71
8	Capiz	.0427	.1324	.1817	.0572	55,507.41	1,394,493.90	10,557.40	49,375.72	1,509,934.43
26	Cavite	.0433	.1414			32,736.82	11,562.50			44,299.32
7	Cebu	.0282	.1919	.2821	.0531	199,974.84	1,529,989.33	70,612.49	525,148.71	2,325,725.37
28	Cotabato	.04	.15	.30		3,052.00	20,489.55	117.00		23,658.55
22	Davao	.0377	.1669	.3166		7,446.23	82,265.95	1,836.28		91,548.46
32	Ilocos Norte	.0542				9,257.73				9,257.73
30	Ilocos Sur	.0444	.13	.2333		8,663.71	3,250.00	590.95		12,504.66
17	Iloilo	.0501	.1608	.2426	.0429	108,778.25	194,849.79	7,283.17	365,490.99	676,402.20
39	Isabela	.1954	.30	.9729	.03	2,461.90	17.10	810.50	1.89	3,291.39
2	Laguna	.0317	.1398	.3604	.0365	218,736.33	2,545,718.31	378,564.10	83,161.67	3,226,180.41
25	Lanao	.06	.1375	.4125		21,683.00	24,624.74	11.013.75		57.321.49
24	La Union	.0427	.1198	.3386		29,406.99	18,227.58	6,032.94		53,667.51
9	Leyte	.0381	.1267	.2072	.0625	317,552.46	897,673.88	28,143.02	351,186.34	1,594,505.70
21	Mindoro	.0379	.1104	.1909	.0572	19,852.72	66,189.99	90.50	8,233.84	94,367.05
5	Misamis	.0221	.1317	.1835	.0396	15,546.48	2,184,281.77	3,257.90	58,980.86	2,262,067.01
33	Mountain	.0561	.1391	.5177	.20	2,035.74	532.33	798.05	25.00	3,391.12
35	Nueva Ecija	.0534		.1466		2,379.89		50.16		2,430.05
41	Nueva Vizcaya	.1730		.3415		1,695.39		114.42		1,809.81
16	Occidental Negros	.0959	.1543	.1718	.0476	125,362.65	297,768.87	1,180.97	99,479.17	523,791.66
13	Oriental Negros	.0330	.1206	.3611	.0523	19,639.60	663,044.96	1,037.11	52,062.53	735,784.20
20	Palawan	.0250	.0990	.15	.0644	12,108.26	63,152.20	408.00	29,378.48	105,046.94
44	Pampanga									
15	Pangasinan	.0406	.3201	.3861		108,889.26	548,622.03	47,225.83		704,737.12
42	Rizal	.05				13.00				13.00
6	Samar	.0434	.1105	.2591	.0569	232,765.31	1,151,975.60	2,468.55	194,360.03	1,581,569.49

11	Sorsogon	.0414	.1304	.1679	.0586	110,460.92	806,765.04	2,469.17	21,457.48	941,152.61
36	Sulu	.05	.13			115.00	1,174.29			1,289.29
14	Surigao	.0411	.1323	.2659	.0620	10,053.44	343,640.52	560.72	42,102.90	396,357.58
31	Tarlac	.0507		.4025		11,418.10		938.37		12,356.47
1	Tayabas	.0283	.1436	.2127	.1135	138,117.22	5,692,079.67	51,224.98	67,854.98	5,949,276.85
27	Zambales	.0372	.1775	.2742	.05	19,055.30	16,307.00	1,257.48	511.25	37,131.03
3	Zamboanga	.0382	.1415	.2784	.148	30,382.20	3,377,647.87	312.19	894.30	3,409,236.56
	Total					2,407,426.90	26,553,152.55	831,809.83	2,183,105.39	31,975,494.67
	General average for the Philippine Islands	.0373	.1423	.3132	.0499					

Classification of coconut trees (estimated):

Tuba trees producing one liter or tuba for six months or 180 liters annually	242,637
Trees too young to bear fruit	29,035,936
Bearing trees averaging 28 nuts per tree annually	30,965,474
Total number of coconut trees	60,244,047

Classification of the nuts:

Nut consumed for food	64,586,492
Estimated nuts used for copra	[a] 789,765,444
Estimated nuts used for oil	[b] 26,236,870
Total nuts gathered	880,588,806

[a] Average of 4.23 nuts to make one kilo of copra.
[b] Average of 10 nuts to make one liter or oil.

NOTE:—If the average distance between coconut trees be considered as 8 meters (26.2 feet) the number of trees per hectare would be 156 and the entire area cultivated would be 386,180 hectares.

If the average distance between coconut trees be considered as 7.07 meters (23.2 feet) the number of trees per hectare would be 200 and the entire area cultivated would be 301,220 hectares.

The area of 301,220 hectares is probably the more exact of the areas mentioned. It represents the entire area of land in the Philippine Islands which is estimated to be devoted to the cultivation of coconut trees.

CORN.

Rank.	Province.	Area cultivated.	Amount of shelled corn produced.		Average production of shelled corn per hectare.		Amount of forage produced.	Average price of shelled corn in the municipal markets.		Total value in the municipal markets.
			Liters.	Cavans.	Liters.	Cavans.	Kilos.	Per liter.	Per cavan.	
		Hectares.								
10	Abra	7,497	8,797,488	117,299.84	1,173	15.65	200	₱0.039	₱2.92	₱346,992.02
29	Agusan	1,520	1,567,150	20,895.33	1,031	13.75		.047	3.52	73,917.50
28	Albay	1,552	1,854,171	24,722.28	1,167	15.56		.045	3.37	82,057.12
21	Ambos Camarines	3,060	4,006,578	53,421.04	1,309	17.45	5,950	.03	2.25	117,841.36
30	Antique	1,612	1,453,765	19,383.53	902	12.03	1,191,260	.031	2.32	45,519.58
37	Bataan	391	381,568	5,087.57	976	13.01	20	.035	2.62	13,241.34
41	Batanes	85	67,395	898.60	793	10.57		.048	3.60	3,207.30
12	Batangas	9,742	8,206,349	109,417.98	842	11.23	428,385	.037	2.77	303,236.36
11	Bohol	13,677	8,715,558	116,207.44	637	8.43		.053	3.97	464,339.17
42	Bukidnon	38	57,000	760.00	1,500	20.00		.05	3.75	2,850.00
16	Bulacan	5,325	5,198,245	69,309.93	976	13.02		.028	2.10	145,627.60
3	Cagayan	28,875	29,131,955	388,426.06	1,009	13.45	700	.032	2.40	945,760.90
20	Capiz	4,709	4,652,791	62,037.21	988	13.17	3,000	.03	2.25	162,054.17
34	Cavite	1,036	796,942	10,625.89	769	10.26		.033	2.47	26,593.76
1	Cebu	140,231	165,373,780	2,204,983.73	1,179	15.72		.034	2.55	5,566,096.56
43	Cotabato	14	10,050	134.00	718	9.57		.04	3.00	402.00
40	Davao	105	88,664	1,182.19	844	11.26	36,888	.037	2.77	3,323.97
19	Ilocos Norte	4,736	4,746,846	63,291.28	1,002	13.36	2,614,152	.046	3.45	219,198.51
13	Ilocos Sur	6,210	6,671,262	88,950.19	1,074	14.32	102,336	.037	2.77	246,817.26
9	Iloilo	11,415	9,271,790	123,623.87	812	10.83		.037	2.77	342,288.90
5	Isabela	22,206	24,865,740	331,543.20	1,120	14.93		.043	3.22	1,062,257.95
31	Laguna	1,174	1,389,804	18,530.72	1,184	15.78	503,000	.038	2.85	53,305.06
35	Lanao	815	529,237	7,056.49	649	8.66		.03	2.25	15,877.11
25	La Union	3,043	2,627,931	35,039.08	864	11.51	160,785	.047	3.52	123,803.65
4	Leyte	25,071	25,424,864	338,998.19	1,014	13.52	20,000	.042	3.15	1,056,451.37
36	Mindoro	408	430,320	5,737.60	1,055	14.06	32,300	.051	3.82	21,996.20
6	Misamis	13,428	17,524,730	333,663.07	1,305	17.40		.036	2.70	637,049.90
14	Mountain	7,699	6,134,886	81,798.48	797	10.62	15,023	.022	1.65	137,720.55
23	Nueva Ecija	2,840	2,994,807	39,930.76	1,055	14.06	99,910	.036	2.70	109,639.36
39	Nueva Vizcaya	248	204,510	2,726.80	824	11.00		.04	3.00	9,072.10
7	Occidental Negros	12,144	17,422,915	232,305.53	1,435	19.13	1,250	.031	2.32	546,230.70
2	Oriental Negros	54,610	71,041,341	947,217.88	1,300	17.34		.04	3.00	3,146,724.29
32	Palawan	892	1,146,525	15,287.00	1,285	17.14		.03	2.25	31,519.75
17	Pampanga	5,024	5,163,461	68,846.15	1,028	13.70	764,560	.034	2.55	173,810.03

8	Pangasinan	12,506	13,119,558	174,927.44	1,049	13.99	2,089,656	.038	2.85	498,366.17
33	Rizal	1,367	1,097,700	14,636.00	803	10.71	9,000	.05	3.75	58,959.85
26	Samar	3,055	2,610,651	34,808.68	855	11.39	1,008	.053	3.97	138,350.33
24	Sorsogon	2,743	2,668,806	35,584.08	973	12.97	6,500	.04	3.00	107,416.28
44	Sulu									
18	Surigao	4,972	4,757,560	63,434.13	957	12.76		.03	2.25	152,519.90
27	Tarlac	2,559	1,865,740	24,876.53	729	9.72	257,760	.052	3.90	96,552.50
22	Tayabas	3,592	3,150,297	42,003.96	877	11.69	68,586	.039	2.92	124,000.25
38	Zambales	386	374,532	4,993.76	970	12.94	27,900	.04	3.00	16,205.68
15	Zamboanga	5,681	6,063,773	80,850.31	1,067	14.23		.034	2.55	210,605.86
	Total	428,293	473,659,035	6,315,453.80			8,440,129			17,639,800.22
	General Average for the Philippine Islands				1,106	14.75		.037	2.79	

LEAF TOBACCO.

Rank.	Province.	Area cultivated.	Amount produced.		Average production per hectare.		Average price in the municipal market.		Total value in the municipal markets.
			Kilos.	Quintals.	Kilos.	Quintals.	Per kilo.	Per quintal.	
		Hectares.							
13	Abra	324	240,588	5,230.17	742	16.130	₱0.176	₱8.09	₱42,355.19
33	Agusan	21	11,060	240.44	526	11.434	.945	43.47	10,460.00
37	Albay	3	1,200	26.09	400	8.695	.150	6.90	180.00
	Ambos Camarines	2							
28	Antique	61	32,980	716.96	540	11.739	.508	23.36	16,778.45
	Bataan								
32	Batanes	24	11,914	259.00	496	10.782	.298	13.70	3,561.78
26	Batangas	90	49,107	1,067.54	545	11.847	.462	21.25	22,736.45
19	Bohol	175	105,204	2,287.04	601	13.065	.462	21.25	48,693.90
38	Bukidnon	3	300	6.52	100	2.173	.500	23.00	150.00
20	Bulacan	203	104,178	2,264.74	513	11.152	.551	25.34	57,432.80
3	Cagayan	8,528	6,565,162	142,720.91	769	16.717	.275	12.65	1,805,934.11
15	Capiz	333	183,204	3,982.79	550	11.956	.295	13.57	54,124.88
34	Cavite	33	9,202	200.04	279	6.065	.293	13.47	2,702.22
5	Cebu	5,869	3,680,099	80,002.15	627	13.630	.182	8.37	670,418.45
	Cotabato								
31	Davao	30	13,650	296.74	455	9.891	.700	32.20	9,555.00
6	Ilocos Norte	1,509	1,200,371	26,095.02	795	17.282	.142	6.53	171,293.90
12	Ilocos Sur	397	314,708	6,841.48	793	17.239	.211	9.70	66,669.80
9	Iloilo	892	637,357	13,855.59	715	15.543	.247	11.36	157,695.60
1	Isabela	22,104	18,905.923	410,998.33	855	18.586	.189	8.69	3,574.867.88
	Laguna								
	Lanao								
2	La Union	7,742	8,544,993	185,760.72	1,103	23.978	.253	11.63	2,169,141.74
8	Leyte	1,764	850,246	18,483.61	482	10.478	.382	17.57	324,989.25
27	Mindoro	78	37,802	821.78	484	10.521	.131	6.02	4,985.40
23	Misamis	180	73,400	1,595.65	408	8.869	.404	18.58	29,690.00
14	Mountain	395	199,306	4,332.74	504	10.956	.201	9.24	40,208.05
11	Nueva Ecija	890	496,734	10,798.57	558	12.130	.243	11.17	121,059.14
17	Nueva Vizcaya	156	159,283	3,462.67	1,021	22.195	.598	27.50	95,405.85
7	Occidental Negros	1,243	887,982	19,303.96	714	15.521	.175	8.05	155,795.30
10	Oriental Negros	971	506,192	11,004.17	521	11.326	.127	5.84	64,386.67
36	Palawan	8	3,750	81.52	469	10.195	.700	32.20	2,625.00
29	Pampanga	34	21,650	470.65	636	13.826	.293	13.47	6,355.00
4	Pangasinan	5,975	4,411,698	95,906.48	738	16.043	.188	8.64	833,173.93

35	Rizal	22	7,579	164.76	344	7.478	.414	19.04	3,140.50
16	Samar	463	165,975	3,608.15	358	7.782	.630	28.98	104,567.25
22	Sorsogon	212	97,643	2,122.67	460	10.000	.348	16.00	34,055.30
------	Sulu	------	------	------	------	------	------	------	------
21	Surigao	187	101,136	2,198.61	540	11.739	.779	35.83	78,837.60
18	Tarlac	569	155,221	3,374.37	273	5.934	.297	13.66	46,208.80
24	Tayabas	129	67,802	1,473.96	525	11.413	.418	19.22	28,369.40
30	Zambales	60	17,372	377.65	289	6.282	.449	20.65	7,803.90
25	Zamboanga	97	56,650	1,231.52	584	12.695	.302	13.89	17,115.00
	Total	61,776	48,928,621	1,063,665.67	------	------	------	------	10,883,523.49
	General average for the Philippine Islands	------	------	------	792	17.217	.222	10.21	------

MAGUEY (CANTALA).

Rank.	Province.	Area.		Amount produced.		Average production per hectare.		Average price in the municipal markets.		Total value in the municipal markets.
		Cultivated.	Harvested.	Kilos.	Piculs.	Kilos.	Piculs.	Per kilo.	Per picul.	
		Hectares	*Hectares*							
16	Abra	10	9	4,500	71.15	500	7.91	₱0.12	₱7.59	₱540.00
	Agusan									
	Albay									
	Ambos Camarines									
13	Antique	50	38	21,930	346.71	577	9.08	.14	8.86	3,070.20
	Bataan									
23	Batanes	2	1	575	9.09	575	9.09	.20	12.65	115.00
24	Batangas	18	1	442	6.99	442	6.99	.13	8.22	57.46
4	Bohol	3,933	2,991	1,453,683	22,983.13	486	7.68	.20	12.65	290,736.60
	Bukidnon									
	Bulacan									
14	Cagayan	149	39	17,100	270.36	438	6.93	.11	6.96	1,881.00
18	Capiz	15	9	3,900	61.66	433	6.85	.12	7.59	468.00
	Cavite									
1	Cebu	10,351	7,584	6,924,241	109,474.17	913	14.43	.22	13.92	1,523,333.02
	Cotabato									
22	Davao	3	1	600	9.49	600	9.49	.13	8.22	78.00
3	Ilocos Norte	3,785	2,835	1,776,538	28,087.56	627	9.91	.15	9.49	266,480.70
2	Ilocos Sur	6,338	6,022	5,236,207	82,785.88	870	13.75	.20	12.65	1,047,241.40
25	Iloilo	17	2	95	1.50	43	.75	.11	6.96	10.45
	Isabela									
	Laguna									
	Lanao									
6	La Union	475	450	244,720	3,869.09	544	8.60	.11	6.96	26,919.20
7	Leyte	496	293	132,790	2,099.45	453	7.20	.18	11.39	23,902.20
	Mindoro	1								
	Misamis									
11	Mountain	108	63	27,806	439.62	441	6.98	.17	10.75	4,727.02
	Nueva Ecija	33								
	Nueva Vizcaya									
10	Occidental Negros	112	67	34,564	546.47	516	8.16	.16	10.12	5,530.24
8	Oriental Negros	296	164	98,663	1,559.89	602	9.51	.21	13.28	20,719.23
	Palawan	3								
	Pampanga	6								

5	Pangasinan	1,570	1,330	1,128,108	17,835.70	848	13.41	.12	7.59	135,372.96
17	Rizal	11	9	4,300	67.98	433	7.55	.12	7.59	516.00
19	Samar	15	8	2,400	37.94	300	4.74	.12	7.59	288.00
15	Sorsogon	111	24	11,730	185.45	489	7.73	.27	17.08	3,167.10
------	Sulu	------	------	------	------	------	------	------	------	------
------	Surigao	4	------	------	------	------	------	------	------	------
21	Tarlac	4	3	1,050	16.61	350	5.54	.26	16.45	273.00
20	Tayabas	10	7	2,400	37.94	343	5.42	.12	7.59	288.00
9	Zambales	123	77	35,177	556.16	457	7.22	.12	7.59	4,221.24
12	Zamboanga	50	50	26,500	418.97	530	8.38	.13	8.22	3,445.00
	Total	28,099	22,077	17,190,019	271,778.96	------	------	------	------	3,363,381.02
	General average for the Philippine Islands	------	------	------	------	779	12.31	.19	12.37	------

CACAO.

[Estimated.]

Rank.	Province.	Trees. Cultivated.	Trees. Bearing.	Amount of cacao produced. Kilos.	Amount of cacao produced. Arrobas.	Average production per tree.	Average price in the municipal markets. Per kilo.	Average price in the municipal markets. Per arroba.	Total value in the municipal markets.
						Kilos.			
40	Abra	515	363	232	20.18	0.672	₱0.7661	₱8.81	₱177.75
34	Agusan	4,465	2,700	1,202	104.52	.522	.47	5.405	566.04
9	Albay	86,113	50,846	24,622	2,141.04	.484	.765	8.797	18,842.90
1	Ambos Camarines	262,094	112,460	54,365	4,727.39	.483	.677	7.785	36,838.75
15	Antique	32,865	24,375	11,661	1,014.00	.478	.661	7.601	7,716.50
35	Bataan	2,980	1,141	953	82.87	.835	.67	7.705	638.79
	Batanes								
7	Batangas	71,857	42,204	36,301	3,156.61	.860	.528	6.072	20,202.59
6	Bohol	95,827	61,825	37,678	3,276.35	.609	.578	6.647	21,806.43
	Bukidnon								
22	Bulacan	12,959	7,936	5,270	458.26	.664	.899	10.338	4,741.45
25	Cagayan	8,206	5,158	3,884	337.74	.753	.601	6.911	2,536.34
18	Capiz	20,598	13,375	8,806	765.74	.658	.499	5.738	4,399.06
10	Cavite	69,084	42,718	23,881	2,076.61	.559	.65	7.475	15,538.95
4	Cebu	97,412	61,082	40,058	3,483.30	.665	.56	6.44	22,771.40
	Cotabato								
30	Davao	8,375	4,685	2,545	221.30	.543	.495	5.692	1,251.25
17	Ilocos Norte	27,087	17,523	10,141	881.83	.573	.498	5.727	5,057.50
37	Ilocos Sur	1,478	998	722	62.78	.723	.907	10.43	654.96
3	Iloilo	114,597	65,141	41,492	3,608.00	.636	.647	7.44	26,881.46
39	Isabela	1,495	448	310	26.96	.691	.612	7.038	189.90
14	Laguna	31,353	20,925	12,751	1,108.78	.609	.699	8.038	8,928.40
38	Lanao	2,600	680	370	32.17	.544	.453	5.209	168.80
2	La Union	97,474	78,507	41,854	3,639.48	.533	.649	7.463	27,184.60
12	Leyte	42,335	21,466	15,109	1,313.83	.719	.623	7.164	10,935.25
16	Mindoro	49,564	22,003	11,474	997.74	.521	.56	6.44	6,429.53
24	Misamis	17,723	10,375	5,049	439.04	.486	.705	8.107	3,561.37
23	Mountain	14,552	8,585	5,081	441.83	.592	.631	7.256	3,204.19
27	Nueva Ecija	7,825	6,366	3,713	322.87	.524	.564	6.486	2,348.34
26	Nueva Vizcaya	6,946	6,156	3,840	333.91	.623	.747	8.59	2,871.01
13	Occidental Negros	32,686	22,393	13,121	1,140.96	.585	.749	8.613	9,831.48
11	Oriental Negros	61,290	37,871	21,912	1,905.39	.575	.687	7.90	15,153.27
36	Palawan	2,202	1,600	931	72.26	.519	.649	7.463	545.51

32	Pampanga	3,784	2,239	1,462	127.13	.653	.758	8.717	1,109.70
8	Pangasinan	66,356	45,426	25,139	2,186.00	.553	.525	6.017	13,198.66
31	Rizal	5,011	2,449	1,629	141.65	.665	.558	6.317	910.00
20	Samar	29,609	15,528	8,621	749.65	.55	.52	5.98	4,488.75
19	Sorsogon	16,899	15,047	8,783	763.74	.583	.698	7.027	6.134.62
----	Sulu	----	----	----	----	----	----	----	----
21	Surigao	43,215	13,638	7,492	651.48	.549	.522	6.003	3,912.77
28	Tarlac	5,843	4,400	2,990	260.00	.679	.668	7.682	1,999.35
5	Tayabas	150,637	61,408	37,890	3,294.78	.617	.596	6.854	22,573.73
33	Zambales	3,549	2,082	1,205	104.78	.578	.724	8.326	873.50
29	Zamboanga	8,550	5,476	2,896	251.83	.527	.451	5.186	1,325.20
	Total	1,618,010	919,598	537,335	46,724.78	----	----	----	338,500.05
	General Average for the Philippine Islands	----	----	----	----	.584	.630	7.245	----

NOTE.—Cacao trees in the Philippines are usually planted too closely together and with no uniformity of distance between trees. The average distance is estimated at 2.5 meters, which would mean a stand of 1,600 trees per hectare. In determining the average production of cacao per hectare it must be borne in mind that, on account of the crowded manner of planting, only 50 or 60 per cent of the trees are in full bearing, the remaining trees being divided among those which bear lightly, those which are non-bearing, and those which are too young to bear fruit.

COFFEE.

[Estimated.]

Rank.	Province.	Trees.		Amount of coffee produced.		Average production per tree.	Average price in the municipal markets.		Total value in the municipal markets.
		Cultivated.	Bearing.	Kilos.	Arrobas.		Per kilo.	Per arroba.	
						Kilos.			
40	Abra	140	94	49	4.26	0.52	₱0.61	₱7.015	₱29.74
36	Agusan	1,519	1,319	685	59.57	.519	.387	4.45	265.00
14	Albay	34,115	18,002	11,421	993.13	.634	.455	5.232	5,087.00
12	Ambos Camarines	49,570	23,436	13,881	1,207.04	.587	.498	5.727	6,912.30
20	Antique	12,097	8,619	6,061	527.04	.703	.572	6.578	3,469.60
33	Bataan	3,874	1,547	1,280	111.31	.827	.537	6.176	685.97
41	Batanes	72	35	30	2.61	.86	.70	8.05	21.00
1	Batangas	146,221	110,689	81,755	7,109.13	.737	.538	6.187	44,016.85
8	Bohol	74,552	48,213	27,486	2,390.08	.571	.551	6.336	15,154.22
	Bukidnon	7,500							
37	Bulacan	3,981	1,014	676	58.78	.667	.574	6.501	388.02
18	Cagayan	18,231	13,200	7,359	639.91	.557	.425	4.888	3,129.70
23	Capiz	10,820	9,196	4,997	434.52	.543	.41	4.715	2,059.65
6	Cavite	152,427	71,805	38,252	3,326.26	.533	.702	8.073	26,843.66
10	Cebu	51,942	36,148	19,360	1,683.48	.536	.445	5.117	8,619.10
	Cotabato								
22	Davao	23,485	11,950	5,915	514.35	.495	.343	3.946	2,033.05
9	Ilocos Norte	45,676	35,416	21,089	1,833.83	.595	.491	5.647	10,356.10
39	Ilocos Sur	750	600	400	34.78	.56	.666	7.659	264.00
17	Iloilo	57,814	14,535	7,845	682.17	.546	.364	4.186	2,853.89
38	Isabela	2,503	1,049	600	52.17	.572	.50	5.75	300.00
24	Laguna	20,274	8,985	4,441	386.17	.494	.566	6.509	2,513.80
5	Lanao	123,800	91,800	45,800	3,982.61	.499	.301	3.461	13,778.50
2	La Union	144,900	128,950	67,886	5,903.13	.526	.421	4.42	28,583.95
31	Leyte	9,129	3,466	1,895	164.78	.543	.525	6.038	996.80
16	Mindoro	38,367	16,307	8,668	753.74	.532	.333	3.83	2,885.39
11	Misamis	38,008	24,219	15,785	1,372.61	.651	.321	3.692	5,067.17
3	Mountain	185,331	112,564	62,447	5,430.17	.555	.469	5.393	29,276.02
21	Nueva Ecija	21,717	8,711	5,989	520.78	.687	.619	7.118	3,694.49
15	Nueva Vizcaya	23,793	19,522	11,223	975.91	.575	.522	6.003	5,863.42
26	Occidental Negros	8,163	6,401	3,418	297.22	.534	.538	6.187	1,841.76
13	Oriental Negros	91,185	22,170	12,743	1,108.09	.574	.472	5.428	6,013.84
34	Palawan	3,724	1,186	848	73.74	.715	.527	6.60	446.55

29	Pampanga	3,770	3,045	2,218	192.87	.727	.552	6.348	1,225.15
4	Pangasinan	114,580	91,745	52,154	4,535.13	.568	.457	5.356	23,837.77
19	Rizal	12,276	11,077	6,339	551.22	.572	.563	6.475	3,573.22
25	Samar	7,933	5,690	3,885	337.83	.681	.46	5.29	1,787.55
27	Sorsogon	6.837	4,322	2,617	227.57	.420	.469	5.394	1,197.93
------	Sulu	------	------	------	------	------	------	------	------
35	Surigao	1,765	1,168	844	73.39	.638	.474	5.451	399.20
28	Tarlac	5,561	3,969	2,446	212.70	.624	.49	5.635	1,197.93
7	Tayabas	80,015	45,337	30,428	2,645.91	.671	.444	5.106	13,402.21
32	Zambales	3,535	2,442	1,490	129.57	.614	.545	6.279	812.80
30	Zamboanga	8,343	2,592	1,915	166.52	.738	.368	4.242	706.00
	Total	1,650,295	1,022,535	594,620	51,706.08	------	------	------	₱281,590.30
	General Average for the Philippine Islands	------	------	------	------	.581	.473	5.439	------

NOTE.—Coffee trees in the Philippines are usually planted too closely together and with no uniformity of distance between trees. The average distance is estimated at 2 meters, which would mean a stand of 2,500 trees per hectare. In determining the average production of coffee per hectare it must be borne in mind that, on account of the crowded manner of planting, only 50 or 60 per cent of the trees are in full bearing, the remaining trees being divided among those which bear lightly, those which are non-bearing, and those which are too young to bear fruit.

RECAPITULATION.

[Compiled from the official reports submitted by the executive officers of 1 city, 774 municipalities, 98 townships, 15 rancherias, and 6 settlements.]

Crop.	Area Cultivated.	Products.	Units.	Amount produced.	Average price in municipal markets.	Value of coconut and sugar cane products in municipal markets.	Total value in municipal markets.
	Hectares.						
Rice	1,225,692	Rough rice	Liters	2,120,753,767	₱0.38		₱81,377,811.71
Abacá	488,500	Abacá (manila hemp)	Kilos	160,953,355	.3951		63,598,136.49
Sugar cane	185,931	Crude sugar	do	362,338,084	.098	₱35,525,048.51	
		Panochas (small cakes)	do	23,460,746	.103	2,414,648.31	
		Basi (a beverage)	Liters	7,016,842	.086	602,996.06	
		Molasses	do	1,969,496	.082	162,014.91	
Total value of all sugar cane products.							38,704,707.79
Coconuts (Average of 200 trees per hectare.	301,220	Ripe nuts as food	Nuts	64,586,492	.0373	2,407,426.90	
		Copra	Kilos	186,510,962	.1423	26,553,152.55	
		Coconut oil	Liters	2,623,687	.3132	831,809.83	
		Tuba (a beverage)	do	43,674,587	.0499	2,183,105.39	
Total value of all coconut products							31,975,494.67
Corn	428,293	Shelled corn	Liters	473,659,035	.037		17,639,800.22
Tobacco	61,776	Tobacco leaf	Kilos	48,928,621	.222		10,883,523.49
Maguey	28,099	Maguey (cantala)	do	17,190,019	.19		3,363,381.02
Cacao (estimated)	1,011	Cacao	do	537,335	.63		338,500.05
Coffee (estimated)	660	Coffee	do	594,620	.473		281,590.30
Total	2,721,182						248,162,945.74

NOTE.—The total area of the Philippines, including all 3,141 islands, islets and reefs, has been reported by the Manila Observatory to be 119,542 square miles, which is equivalent to 309,615 square kilometers, or 30,961,500 hectares.

The area under cultivation in the six principal crops and three of the minor crops, as shown in the above table, is only 2,721,182 hectares. This is 8.8 per cent or about one-twelfth of the whole area of the Islands, including mountains and arid lands.

The area under cultivation in fruit trees, bananas, camotes, ubi, gabe, and other vegetables is not included in the above table for the reason that complete statistics on those crops are not available.

Mr. MACK CRETCHER

Assistant Director of Agriculture who has so ably assisted Director Hernandez in the administration of Bureau affairs during the past two years.

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ILLUSTRATIONS.

EDITORIAL.

THE SHOWING MADE BY THE BUREAU OF AGRICULTURE.

By MACK CRETCHER, *Asst. Director of Agriculture.*

The statistic compiled annually by the Bureau of Agriculture show a remarkably prosperous condition for Philippine Agriculture, regardless of the statements so often made by the ignorant and misinformed that no progress is being made in agriculture; that the great industry is languishing; that the food campaign is not producing adequate results; that the Bureau of Agriculture is proving a failure, and other charges equally as groundless.

The compilation of the Bureau statistics was commenced in the year 1913 and is complete for the five-year period up to the fiscal year ending June 30, 1917. It is regretted that the figures up to June 30, 1918, are not yet available as it is known that an even better showing could be made in that event. It may be admitted frankly that the statistics compiled are not as accurate as might be desired, for various reasons, but they contain the most accurate and complete information obtainable in this country, and having been carefully compiled for a period of years, at least have a comparative value, year with year, which is unquestioned, for the six leading crops of the Islands, namely, rice, abaca, sugar, copra, corn and tobacco, the rank of these products being in the order named.

In order to compare the progress made, the total production for the first four years of the statistics record was obtained and this amount divided by four to obtain the average annual production for the four-year period. With this average annual production the statistics for the year ending June 30, 1917, are compared, and a substantial increase is shown on every one of the six leading farm products, not only in the actual money value of the crops, but also as to the amount produced and the acreage planted. The figures quoted are also given only in round numbers, but are capable of verification in the statistical section of the Bureau of Agriculture at any time, where the complete figures and data may be obtained if desired.

That the year 1917 was a banner year is beyond question. The average annual value of the six leading farm products for the four years preceding, 1913 to 1916, was ₱167,000,000 per annum. For 1917, the value of the crops produced jumped to ₱241,000,000, a net gain of ₱74,000,000 in a single year. In other words, a per capita gain of from ₱7 to ₱8 for every man, woman, and child in the Philippines, Christians, Moros, Negritos, and all others. Of course, it will be easy to dispose of this magnificient showing, by stating that the big gain is due to war prices. Is it? well, how about the increase in hectarage and the increase in yield? Does the war in Europe cause crops to produce more per hectare as well as to bring a better price? There was not only the money value of ₱74,000,000 gained but there was an increase of more than 179,800 hectares in area planted and in kilos and liters of crops produced the gain was above 625,000,000 over the average yield of the previous four years. Those figures are substantial enough to convince even the scoffers and the uninformed, and furnish material for one of the biggest boom stories the Philippines have produced in recent years.

Take abacá, for instance, Our records show that for the fiscal year ending June 30, 1917, there were 488,000 hectares planted to this crop, which yield 160,000,000 kilos valued at 63,000,000 pesos. The annual average for the previous four-year period was 440,000 hectares, producing 148,000,000 kilos, valued at ₱33,000,000, an increase for 1917 of 48,000 hectares, 12,000,000 kilos and ₱30,000,000.

Rice was a close second, the annual hectarage being 1,164,000 that yielded 1,610,000,000 liters, valued at ₱56,000,000. For 1917, the hectarage was 1,225,000, which produced 2,120,000,000 liters worth ₱82,000,000, a gain of 61,000 hectares, 510,000,000 liters in production and ₱26,000,000 in value.

Despite the depression in sugar, the figures show an advance. The annual average hectarage for the four-year period was 177,000, the yield of crude sugar 337,000,000 kilos, value of all cane products. The hectarage for 1917 climbed to 185,000, producing 362,000,000 kilos of crude sugar, cane products value ₱38,000,000, a gain of 8,000 hectares, a gain of 25,000,000 kilos of crude sugar and a gain in value of ₱8,000,000.

The four-year average of hectares planted to coconut trees was 254,000, the average annual output of copra was 134,000,000 kilos, the value of all coconut products was ₱25,000,000. In 1917, there were 301,000 hectares growing coconuts, which

produced 186,000,000 kilos of copra, the value of all coconut products being a gain of 47,000 in hectarage, 52,000,000 kilos in production and ₱6,000,000 in value.

During the same four-year period the average hectarage planted to corn was 419,000, the average annual yield being 452,000,000 liters, worth approximately ₱15,000,000. In 1917 the hectarage was 428,000, the yield 473,000,000 liters and the value ₱17,000,000, a gain of 9,000 in hectares planted, 21,000,000 in liters produced, and 2,000,000 in value.

For the same years the tobacco area averaged 58,000 hectares, producing an average of 43,000,000 kilos per annum, valued at ₱8,000,000. The year 1917, shows 61,000 hectares planted, 48,000,000 kilos yield and ₱10,000,000 value, a gain of 3,000 in area, 5,000,000 kilos in production and ₱2,000,000 in value.

That the four-year average upon which the above comparisons are made is a fair one may be concluded from the fact that the statistics for the years ending June 30, 1913, and June 30, 1914, represented conditions before the world war started, while the two laters years were during war times, thus dividing about equally the period upon which averages were made.

In view of the above figures, which are the most reliable obtainable in this country, the person who declares that no progress is being made in agriculture in the Philippine Islands is either grossly ignorant, misinformed or willfully malicious.

While the previous article shows clearly the increased production and gains in our six leading agricultural crops for the year 1917 over the average for the preceding four years, the following table will show as clearly the increase in the live stock of the Islands from shortly after American occupation to the present time. It does not show however the increased value of live stock due to the improvement of breeding methods, introduced by the Bureau of Agriculture through the introduction of pure bred sires, and in certain sections where the Bureau's efforts have been most fully appreciated and the people have coöperated the increase in value has been over 100 per cent which added to the numerical gain makes a showing that proves the value of the Bureau's efforts in behalf of the people.

Year.	Population.	Carabaos.		Cattle.		Horses.		Hogs.		Goats.		Sheep.	
		Number.	Per 100 of population.	Number.	Per 100 of population.	Number.	Per 100 of population.	Number.	Per 100 of population.	Number.	Per 100 of population.	Number.	Per 100 of population.
1903	6,987,686	640,871	9.17	127,559	1.82	144,171	2.06	1,179,371	16.88	124,334	1.78	30,428	0.43
1910	8,713,668	756,724	8.68	269,963	3.10	142,604	1.64	1,681,550	19.30	441,455	5.07	94,166	1.08
1011	8,866,157	863,649	9.74	315,495	3.56	151,696	1.71	1,703,078	19.21	455,291	5.13	93,341	1.05
1912	9,021,315	958,512	10.62	362,230	4.01	170,861	1.89	1,888,122	20.93	475,794	5.27	98,656	1.09
1913	9,179,188	1,047,164	11.41	418,114	4.55	179,089	1.95	2,016,736	21.97	528,180	5.75	104,147	1.13
1914	9,339,824	1,147,433	12.29	477,736	5.11	215,826	2.31	2,285,880	24.47	592,042	6.34	118,010	1.26
1915	9,503,271	1,221,866	12.86	534,106	5.62	223,195	2.35	2,521,143	26.53	644,026	6.78	129,470	1.36
1916	9,669,500	1,228,836	12.71	566,199	5.85	203,430	2.10	2,734,684	28.28	[a] 604,332	6.25	[a] 130,034	1.34
1917	9,838,700	[a] 1,241,000	12.61	[a] 535,000	5.44								

[a] Estimated.

DESCRIPTION OF THE STANDARD GRADES OF PHILIPPINE FIBERS.

Excerpts from the fiber number of the Philippine Agricultural Review, first quarter, 1916,
By M. M. SALEEBY, *Former Chief, Fiber Division.*

The number and designation of the official standard grades of the chief commercial fibers of the Philippine Islands are given in Article III of Bureau of Agriculture General No. 54. In Article II of this order are explained the principal characteristics which, in each of the fibers included in the regulations, determine the grade and its type, but no attempt is made to give a specific description of each grade. It is the object of this paper to give such a description and it intended that this description shall be based on the apparent qualities of the fiber in each grade, and the variations which may be encountered in the character of the fiber in the different districts where it is produced.

Such a description is difficult in the case of abacá, perhaps more so than of any other hard fiber, and it is presupposed that the reader has a practical knowledge of the commercial grades of this fiber before he can thoroughly understand this description. It is true that an accurate understanding of the grades of abacá can be obtained only by continued examination and handling of the fiber on a more or less large scale. The same thing is true in the case of almost all other fibers although abacá presents a particular difficulty owing to the variable methods used in its preparation and preliminary handling. In spite of all these difficulties, it is believed that a specific description of the grades as is proposed in this article, although it may be practically unintelligible to the layman, may prove of considerable help to all persons who have had experience with Philippine fibers.

For the purposes of this article the standard grades of abacá are classed under four groups, acording to the extent of their cleaning, or fiber extraction. The grades of each group will be described separately, beginning with the lowest grade, thus showing as clearly as possible the gradation which exists in their apparent characteristics.

STANDARD GRADES OF ABACÁ (MANILA HEMP).

GROUP 1.—*Those of excellent cleaning.*

The grades included in this group are "Extra prime" to "Streaky No. 3," excluding "Current," which is oftener of good than of excellent cleaning. In these grades the cleaning is perfect, or nearly so, and the product is practically pure fiber, hence the texture is generally soft (except in the product of South and North Mindanao which is sometimes medium in texture) and the tensil strength is at its highest average. During 1915, 288,159 bales of abacá of this group were produced, which represent 28.4 per cent of the total production for the year. While the grades of this group are to a greater or less extent produced in every province, they form the bulk of production only in Cavite, Mindoro, South Mindanao (Davao Province), Samar, West Leyte, Tayabas (Marinduque), and Panay (Capiz and Iloilo). During the year 1916 and 1917, however, Camarines ranked one among the provinces which produced the greatest bulk of the fiber of this group, and in 1917, there were produced 382,117 bales of abacá of this group, representing 28.8 per cent of the total production for the year.

Streaky No. 3.—This grade is produced entirely from the outside sheaths of certain varieties of the abacá plant, the color of which is naturally dark. For this reason the predominant *color* of the fiber is a light purple, with but few streaks of dingly white fiber running through it. The color of the fiber from the middle toward the tip is usually darker than the rest. In this grade, the fiber is invariably short, rarely exceeding 1.25 meters (4 feet) in length.

Streaky No. 2.—This grade is produced from sheaths next to those on the ouside of the abacá stalk of the same varieties from which "Streaky No. 3" is produced, or from the outside sheaths of other varieties in which the stalks are naturally of a lighter color. The *color* of this fiber is a mixture, in more or less equal proportion, of dingy white and red, or light purple. The fiber is almost invariably short, rarely if ever exceeding 1.5 meters (5 feet) in length.

Streaky No. 1.—This grade is also produced from the few sheaths next to those on the outside of the abacá stalk. These sheaths are slightly longer and less colored than the outer ones, hence the predominant *color* of the fiber is a light ivory-yellow or light ochre, mixed with a few streaks of a light reddish color.

Midway.—This grade is as a rule obtained from the middle sheaths of the abacá stalk which are of a light ochre color and

Abacá (Kinisol variety).

extend the whole length of the stalk. Purple or red colors in any noticeable quantities are absent in this grade, and the length of the fiber is entirely governed by the extent of growth of the plant. In the typical grade, the characteristics *color* of the fiber may be described as ochre, often interspersed with traces of a light ivory-yellow color which really belongs to the next higher grade. The proportion of "Midway" fiber in the abacá stalk, when the fiber is cleaned and dried carefully, does not exceed 10 to 15 per cent. This proves that the bulk of the production of this grade in such provinces as Samar, Leyte, and North Mindanao cannot be entirely typical. A large proportion of "Midway" fiber as it is generally encountered in the market is nothing more than a "Good current" fiber which has depreciated in color on account of improper drying and handling. Such Midway fiber may be distinguished from that of the typical grade by the lack of the luster which the latter often exhibits.

"Midway" fiber is not infrequently encountered in which the cleaning cannot be called strictly excellent, it being slightly strippy and more in the nature of "Current" fiber. In such cases, however, the strips are usually soft and fine, with a high color almost approaching that of "Good current." Sorsogon and Albay "Midway" are often of this nature.

In point of production, this grade ranked fifth among the entire grades of abacá during the year 1915, when 115,600 bales, of 11.4 per cent, were produced. Of this amount, Leyte produced 38,747, Samar 25,803, North Mindanao 20,451, and Sorsogon 10,803 bales. In 1917, however, it ranked fourth the entire grades, when 145,361 bales were produced, representing 11.0 per cent of the total number of bales produced during the year, Leyte being the leading province with 43,700 bales, North Mindanao with 27,128 bales, Samar 20,320, Sorsogon 16,462, and South Mindanao 15,066 bales.

Good Current.—The predominant color of the fiber in this grade is a very light ochre, interspersed with considerable quantities of a light ivory-yellow fiber. The *length* of fiber is normal or long, depending entirely on the extent of growth of the plant. The texture is generally soft, except in the case of the varieties of the plant which produce a fiber naturally of a hard or medium texture.

This grade is the lowest of the so-called superior grades, and the production of this has, during the last nine or ten years, generally failed to meet the demand for it. During 1915, only

57,161 bales of this grade were produced out of a total annual production of 1,011,366 bales, or 5.6 per cent. It will be well for the industry if the production of this grade can be increased at the expense of some of the low, strippy grades. It may be safely stated that in those provinces where more or les up-to-date methods are being used by the progressive element of producers, the average production is rarely under "Good current" and in some cases it is even higher. During 1917, the production of this grade has increased to 77,695 bales, out of the 1,291,851 bales produced, or 5.8 per cent.

Superior Current.—The *color* of fiber in this grade is a light ivory-yellow, a considerable portion of which usually approaches white. In *length, texture,* and *cleaning* the fiber is essentially the same as in "Good current," perhaps slightly softer and better cleaned in some instances.

This grade, although the third in regard to quality, can safely be called the highest for cordage purposes, the "Prime" and "Extra prime" grades being used only on a very small scale for this purpose. The production of this grade is also, unfortunately, much below what it should be, amounting during 1915 to only 34,323 bales, or 3.4 per cent of the total production for the year. Even this quantity is not all available for cordage as quite a large proportion of it is used in Japan for the manufacture of hat braid, commonly known as "tagal." Same may also be mentioned of the grade "Good current" of which a proportional amount is exported to Japan for the same purpose. During the year 1917, the production of this grade amounted to 50,907, representing 3.7 per cent of the total production for the year.

Prime and extra prime.—These grades constitute the second and first, respectively, of the superior grades. They are described together because their characteristics are very much the same in respect to *texture, cleaning,* and *length* of fiber. The *color* of the fiber in both grades is practically white, although it is a little more so in "Extra prime." These two grades are obtained from the interior sheaths around the core of the abacá stalk. These sheaths are naturally whiter, softer, and a little shorter than those immediately surrounding them. For this reason, the texture is always soft, irrespective of the variety of plant or district of production.

The best fiber of these grades comes from the Provinces of Cavite, Davao, and Camarines. In fact, these provinces produce the bulk of this fiber. The production of "Extra prime"

and "Prime" during 1915 amounted to 27,493 bales, of which Cavite produced 9,380 bales, Davao about 3,117 bales, and Camarines 6,749 bales; while in 1917, the production amounted to 29,751 bales, Cavite producing 8,372, Davao 4,601, Camarines 6,774, and Albay 1,006 bales. By far, the larger proportion of these two grades is being exported to Japan for the manufacture of tagal braid, for which very much higher prices are paid than can possibly be paid by the cordage trade.

GROUP 2.—*Those of good cleaning.*

The grades included in this group are "Current," "Seconds," and "Brown." The grade "Good fair" as produced in Samar, West Leyte, and a few other provinces or districts producing the so-called soft grades comes under this group, but the grade in general belongs to the next group, in which it will be included.

In these grades, the cleaning is not perfect and the product is usually in the form of very fine soft strips, or a mixture of pure fiber and fine, soft strips, which for all practical purposes may be considered fiber, the latter form being perhaps more prevalent. For this reason the cleaning is generally described as "good," and the texture as "medium." During 1915, 213,623 bales of this group of grades were produced, or 21.2 per cent of the total production for the year; while in 1917, there were produced 279,792 bales of this group, or 21.6 of the entire production for the year. The bulk of these grades comes from Leyte, Samar, Sorsogon, and North Mindanao, Leyte leading in production, although a proportional amount is produced in South Mindanao and Albay provinces.

Brown.—This is the lowest grade in this group. Its *color* is usually dark brown or brown, more so toward the tips of the fiber, due to the fact that the tips of the outside sheaths of the abacá stalk from which it is produced are thin and are usually in a more or less dried condition thus rendering the separation of the pulp difficult. The grade "Brown" as produced in East Leyte is usually of a darker color than in most other provinces, due to the prevalence there of varieties of the plant having dark-colored stalks. The *texture* of the fiber is usually medium and its *length* short.

This grade is sometimes encountered in fiber originally of a higher grade, but which owing to subsequent neglect in proper handling and drying, has become dark. Such fiber usually has a greater length than that of the typical grade. This grade corresponds to "Streaky No. 3" of the grades of excellent clean-

ing, the difference betwen them being in the extent of cleaning, which accounts for the darker color and comparatively harder texture of the grade "Brown."

Seconds.—This grade is produced from the same sheaths of the abacá stalk from which "Streaky No. 2" is produced, the difference between the two grades being in the extent of cleaning, the same as that between "Brown" and "Streaky No. 3." The *color* of fiber in the grade "Seconds" is therefore a mixture, usually light green with light brown, the tips being generally darker than the rest, similar to the Streaky and "Brown" grades. The *length* of the fiber in the typical grade is oftener short than normal.

It is not always the natural color of the stalk which is responsible for the peculiar mixed color of this and the "brown" and "streaky" grades, but any considerable injuries to the stalk, such as bruises, or partial decay caused by felling or delay in cleaning of the fiber, produce the same or a similar effect. In the latter case, however, the color is more of a light yellow or red than light brown or green.

This grade also may be encountered in fiber originally of a higher grade, but which, owing to improper cleaning and drying, becomes a little too dark for that grade. The color of such fiber differs from the typical color described above, being dingy red or light brown throughout.

Current.—The *color* characteristic of this grade is as hard to described as those of the grades "Midway" to "Extra prime." It is a shade of very light brown, and is caused by the action of the acid when this is allowed to remain on the fiber for any lenght of time. This often happens when the fiber is either not thoroughly cleaned or when it is not dried promptly after its separation from the pulp. The *texture* of the fiber is medium, except in those cases in which a "Midway" fiber has so deteriorated in color as to render necessary its grading as "Current." Such fiber will be described as being of soft texture and excellent cleaning (this is the grade 37½ over current of the old standard), and is usually produced in Samar, Leyte, and in some unimportant districts, such as Mindoro, Marinduque, Cebú, and others, where the superior grades form the bulk of production. The *length* of the fiber is normal or long, the latter being produced chiefly is some of the North and South Mindanao Provinces.

This grade is unquestionably the most important of all the grades of abacá which are of good or excellent cleaning. Its

PLATE III.

Native apparatus for stripping abacá showing how to place the leaf sheath under the knife.

importance does not consist in any superior quality of its fiber, but in the extent of its supply and the demand for it. During 1915, there were 148,650 bales of this grade produced, of which 61,497 bales came from Leyte, 24,705 bales from Samar, 20,013 bales from Sorsogon, 19,668 bales from North Mindanao, and 11,149 from Albay. In 1917, the production of this particular grade amounted to 214,696 bales, of which Leyte produced 92,898, Samar 41,313 North Mindanao 37,359, South Mindanao 16,289, and Sorsogon 10,907 bales.

GROUP 3.—*Those of fair cleaning.*

The grades included in this group are "Good fair," "Fair," and "Medium." In these grades the cleaning is generally described as fair, and the texture hard, the product being either pure strips or slightly mixed with fiber proper. The strips are usually 1 to 1½ millimeters in width. The two lower grades of this group are the highest grades of the so-called U. K. (United Kingdom) fiber, for the reason that nearly all of this fiber produced is purchased by British cordage manufacturers. During 1915, there were produced 297,212 bales of the three grades of this group, or 29.4 per cent of the total production for the year. In 1917, there were produced 370,518 bales of abacá of this group, representing 29.2 per cent of the entire production for the year. The bulk of these grades is produced in the Provinces of Leyte, Albay, and Sorsogon. The first two provinces are credited with over 98,000 bales each, and the last with over 60,000 bales, for the 1915 production, However, during the last two years, Samar and the North Mindanao provinces produced also a proportional amount of abacá fiber of this group.

Medium.—The *color* of fiber in this grade ranges from light to dark brown, or, in other words, it comprises the low second, and brown colors. The *length* of fiber is usually short in the typical grade, and normal in fiber originally prepared as "Fair" and subsequently reduced to this grade on account of improper drying and handling.

Fair.—This grade is the highest among the so-called U. K. grades, corresponding, as a rule, to the grade "Fair Current U. K." of the old standard. In *color* it ranges from that of high seconds to current, and in *length* it is almost invariably normal, being rarely long or short. When of the color of high seconds, and comparatively soft in texture, this grade is more or less equivalent to "Superior Seconds U. S." of the old standard.

The typical grade coming from Albay or Camarines, which is of hard texture and good color, is more in demand for the European trade.

Good fair.—Owing to the variable method of cleaning abacá fiber in the several provinces, a large quantity of fiber is produced which is considered too good for "Fair" and too low for "Current." Its color, cleaning and texture are also such as would render undesirable its inclusion in "Seconds." For these reasons, it was considered necessary to establish a separate grade for this fiber.

Typical "Good fair" fiber is of fair *cleaning,* hard *texture,* and current *color,* and is generally produced in Albay, Sorsogon, and Camarines. Such "Good fair" fiber as comes from Samar, Leyte, and other provinces which produced superior grades mostly, is, as a rule, of good cleaning and medium texture, the same as "Current," but too low and dingy in color to be placed in the latter grade. The *length* of fiber is generally normal, as in the grades "Current" and "Fair."

In point of production, this grade ranks third, having to its credit 148,558 bales for the year 1917, while the one higher, grade "Fair," ranks the second, with 162,715 bales for the year 1917.

GROUP 4.—*Those of coarse cleaning.*

The grades included in this group are "Coarse," "Coarse brown," "Daet Coarse," and "Daet coarse brown." The fiber in the two latter grades is more in the nature of straw material than actual fiber, hence their description will be given after that of the first two grades of the regular standard. The fiber in the grades of this group is in the form of pure strips and may be described as hard in *texture* and of coarse *cleaning,* with some variation of degree in the several districts of its production. The production of the Daet type of fiber is unfortunate in the extreme, and judging from experience during the first year of the operation of the fiber law, it is possible that it will be gradually eliminated from the market at no distant date.

Coarse brown.—Strictly speaking, this is the lowest of the grades proper. In *color* it is the same as that of "Medium," ranging from that of low seconds to brown; in *texture,* it is always hard, although comparatively softer in some provinces or districts than in others; and in *cleaning,* it is always coarse, the strips being distinctly wider and, as a rule, thicker than those of the grade "Medium." The *length* of fiber is either short or normal, not infrequently mixed.

PLATE IV.

Native method of stripping abacá first and second processes.

Coarse.—This is the highest grade of this group. Its color is similar to that of "Fair," ranging from that of "high seconds" to "Current." In *texture* and cleaning, it is identical with the preceding grade.

Practically the entire supply of "Coarse" and "Coarse brown" is exported to Great Britain and other European countries, where they are the most popular grades, not for any superior quality, but for economic reasons. The best type of these grades is produced in Legaspi (Albay) and Lagonoy (South Camarines).

Daet grades.—In *color* and *length* of fiber the "Daet coarse" and "Daet coarse brown" are identical with "Coarse" and "Coarse brown," respectively. The cleaning of the fiber in the former grades, however, is so poor and the strips are so wide and thick that it is with only a stretch of the imagination that can be considered as fiber. For this reason, these have been designated in General Order No. 54 under the standard for woody fibers. This type of fiber is porduced mainly in Camarines, the Tabaco and Virac districts of Albay, and a little is produced in the districts of North Mindanao.

It is very doubtful whether the Daet grades can be used to advantage for cordage purposes, except perhaps as a mixture with the higher grades. There can be no doubt that the production of this type of fiber has hurt the reputation of our abacá, and for this and local economic reasons, its production should be discouraged. During March and April of 1915, a worse type of strippy product appeared on the local market, coming from the Buhi district of South Camarines, and the then chief of the fiber division of the Bureau of Agriculture immediately instructed all fiber inspectors in Southern Luzon not to grade it under any standard, even under the "Daet type." This prompt action resulted in its disappearance from the market in less than two months after its first detection.

STANDARD GRADES OF MAGUEY AND SISAL.

GROUP 1.—*Retted fiber.*

There are three grades of maguey and sisal in this group, which included all fiber that is cleaned by retting the leaves in water. Such fiber is distinguished by its softness, lack of luster, a marked deficiency in its tensile strength, and in most cases by the presence upon it of gummy scales. These scales are caused by the leaves bruising one another with their terminal spines when swayed by the wind. It is often hard to distinguish be-

tween retted maguey and retted sisal as the retting process destroys the original color and texture, which are the only distinguishing characteristics.

Maguey or Sisal No. 3.—In this grade, the retting process is usually carried to excess thus causing considerable discoloration and deficiency in strength, especially toward the tips of the fiber. The scales are abundant in most cases. Maguey or Sisal No. 3 may therefore be described as being of fair *cleaning*, low *color*, and low *strength*.

In all cases in which the fiber is either overretted, causing excessive discoloration and deficiency in strength, or insufficiently retted, causing the presence of hard woody strips, the fiber is considered as damaged and is graded as such.

Maguey or Sisal No. 2.—In this grade the retting process is usually done properly, the scales are scarce and the strength normal, but the fiber is not subsequently well washed and dried, hence the color is a dingy white. This grade may, therefore, be described as being of good *cleaning*, good *color*, and normal *strength*.

Maguey or Sisal No. 1.—The retting process, as well as the subsequent operations of washing and drying, are properly and carefully carried out in all fiber of this grade, with the result that the color is white, the scales absent, and the strength good. This grade is therefore usually described as being of excellent *cleaning*, high *color*, and good *strength*.

GROUP 2.—*Knife or machine cleaned fiber.*

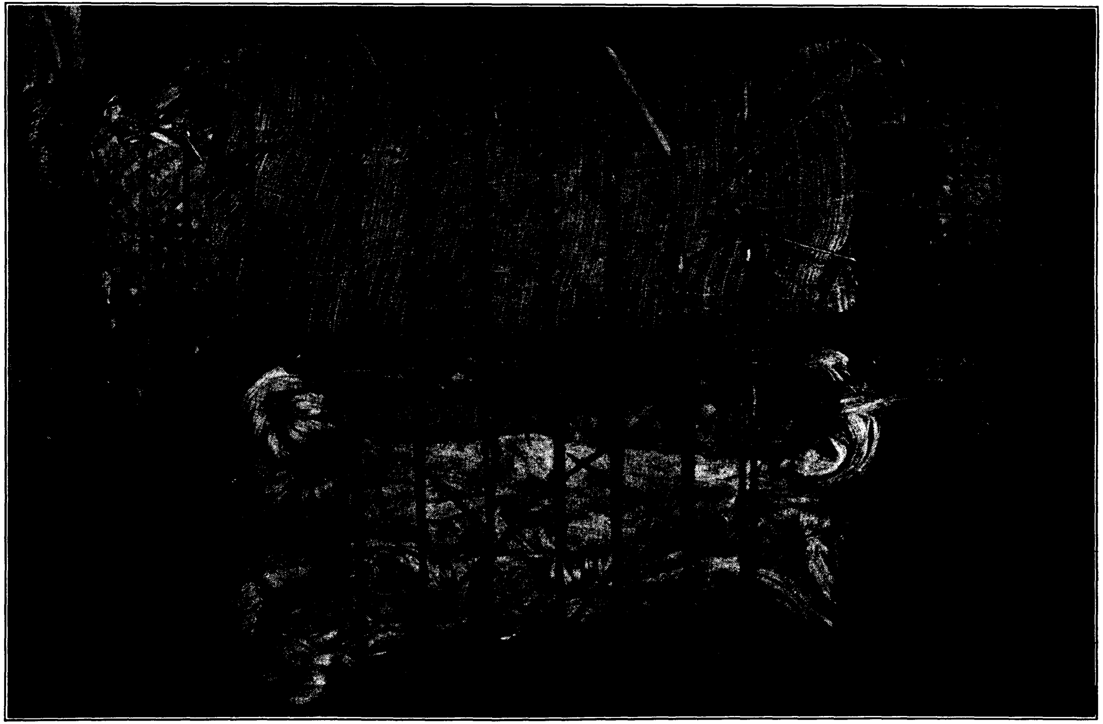
The grades included in this group are "Maguey or Sisal, Good," "Maguey or Sisal, Fair;" and "Maguey or Sisal, Common." The fiber in these grades is generally uniform in cleaning and tensile strength, therefore the grade is determined by the color.

Knife or machine cleaned fiber is superior to the retted fiber in strength and luster, and may be easily distinguished from the latter by its harsher texture and freedom from scales. The production of such fiber is very limited, however, and efforts are being made by the Bureau of Agriculture to encourage its production on a large scale. The small quantities of this class of fiber so far produced compare very favorably with the best grades of German East Africa and Java sisal.

Knife or machine cleaned maguey can be easily distinguished from similar cleaned sisal. Maguey is comparatively softer, finer, and of a whiter color than sisal, the color of the latter fiber being slightly yellowish.

No. 1530.—Drying abacá fiber at Cabadbaran, Agusan.

PLATE VI.



Abacá bales, selected grades covered with matting (two processes).

Maguey or Sisal, Common.—This is the lowest grade of this class of fiber, the dominant color of which is either dingy red or greenish. The former color is caused by harvesting overmature leaves, which are usually marked by bruises or by a partial drying up; while the latter color is caused by delay in drying the fiber, or by neglecting to wash it immediately after cleaning.

Maguey or Sisal, Fair.—In this grade the color of the fiber is generally a dingy white, due mainly to neglect in not drying the fiber immediately after cleaning. In some instances the fiber is dried before washing away the traces of green pulp left attached to it, with the result that it then exhibits a light greenish rather than dingy white color.

Maguey or Sisal, Good.—In this grade the fiber is white and lustrous, and is the result of perfect cleaning and prompt washing and drying. If the process of cleaning is not faulty in any way, and the washing and drying of the fiber is promptly and properly executed, all the fiber turned out should be of this grade. In other words, the color of the leaves of the normal maguey or sisal plant and the character of the fiber they contain is exactly the same in all the mature leaves, hence the color of the fiber is entirely dependent upon the manner of cleaning it and extent of care with which it is thereafter handled. In the case of abacá, however, the variety of the plant, the structure of the stalk, and the character of the sheaths forming it, are in themselves directly responsible for at least four or five distinct grades.

TABLE A.—*Total production of abacá (Manila Hemp) in bales by provinces and grades during the year 1917.*

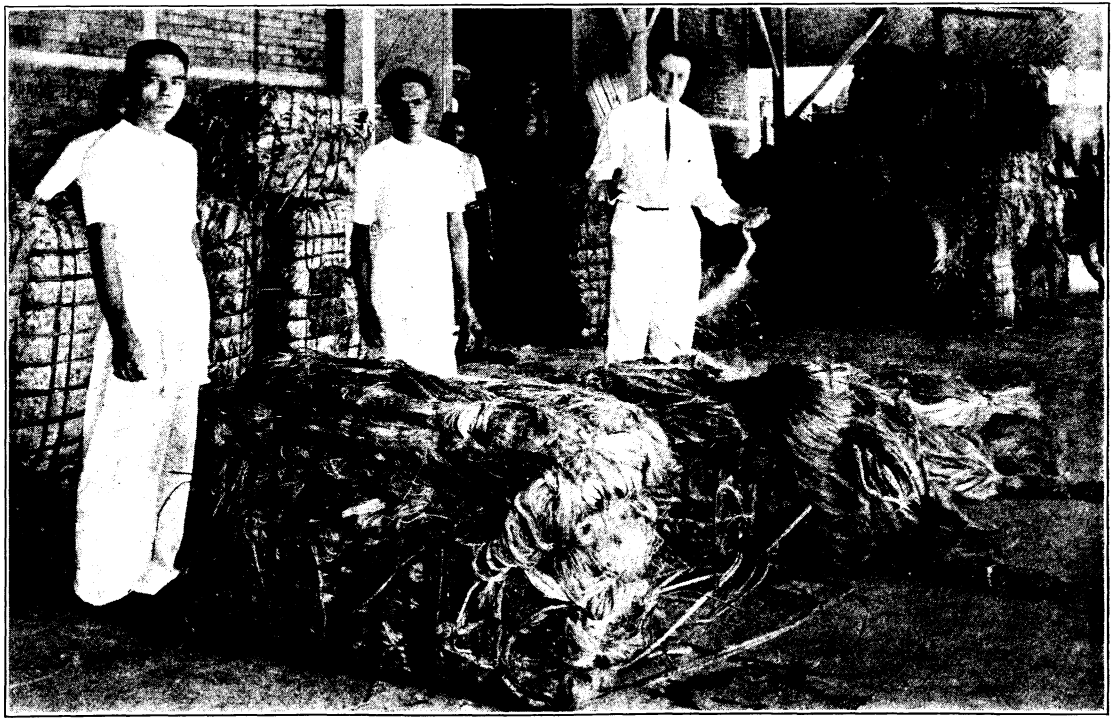
District of production.	Standard Grades.									
	A.	B.	C.	D.	E.	S1.	S2.	S3.	F.	G.
Albay	395	611	1,511	3,223	3,889	648	524	268	4,720	2,604
Leyte	-------	14	552	7,426	43,700	3,536	13,695	9,205	92,898	16,198
Camarines	1,225	5,549	12,454	7,751	2,744	1,233	709	277	751	216
Sorsogon	42	1,805	11,335	20,430	16,462	2,400	3,440	1,972	10,907	2,549
Samar	31	95	404	4,546	20,320	1,917	8,227	9,396	41,313	10,373
North Mindanao	-------	1	165	4,288	27,128	1,363	5,110	2,524	37,359	6,007
South Mindanao	1,033	3,568	10,730	15,790	15,066	2,332	3,206	1,281	16,289	2,394
Cavite	4,291	4,081	3,299	268	33	16	-------	-------	-------	-------
Mindoro	14	284	3,638	6,726	3,565	84	199	71	806	8
Tayabas	1	22	168	219	88	4	5	-------	56	15
Cebu	-------	-------	8	792	6,814	1,677	970	175	4,806	213
Various	2,048	4,641	6,643	6,236	5,552	704	913	322	4,791	1,096
Total	9,080	20,671	50,907	77,695	145,361	15,914	36,998	25,491	214,696	41,673
Percentage	0.7	1.6	3.7	5.8	11.0	1.2	2.8	2.0	16.0	3.3

TABLE A.—*Total production of abacá (Manila Hemp) in bales by provinces and grades during the year 1917*—Continued.

District of production.	Standard Grades.									
	H.	I.	J.	K.	L.	M.	DL.	DM.	O, Y. T.	Total.
Albay	4,377	16,432	77,901	23,647	30,907	12,776	20,591	6,880	2,237	214,141
Leyte	9,487	56,194	40,041	21,421	35,580	7,226	373	22	11,159	362,677
Camarines	555	985	6,043	2,908	23,479	8,861	9,140	7,098	1,821	93,799
Sorsogon	3,436	15,319	21,491	8,091	6,260	1,129	183	71	2,469	129,791
Samar	3,625	27,022	8,294	700	373	44	------	------	3,356	140,036
North Mindanao	1,636	21,017	7,276	1,895	14,840	8,966	9,576	4,975	3,751	157,877
South Mindanao	95	8,001	195	20	11	3		------	1,566	81,580
Cavite	------	------	------	------	------	------	------	------	697	12,685
Mindoro	2	12	1	------	------	------	------	------	39	15,449
Tayabas	------	23	81	9	944	266	1,709	1,002	75	4,637
Cebu	16	936	149	21	8	4	1	------	74	16,664
Various	214	2,617	1,243	533	1,445	4,635	6,436	5,149	1,217	56,465
Total	23,423	148,558	162,715	59,245	113,847	43,910	48,009	25,197	28,461	1,291,851
Percentage	1.8	11.6	12.8	4.8	8.9	3.4	3.6	2.0	2.5	100

TABLE B.—*Comparative summary of production of abacá (Manila Hemp) according to grade for the years 1915, 1916, and 1917.*

Grades.	1915		1916		1917	
	Bales.	Percentage.	Bales.	Percentage.	Bales.	Percentage.
Extra prime	9,678	1.0	7,325	0.6	9,080	0.7
Prime	17,815	1.7	11,039	0.9	20,671	1.6
Superior current	34,323	3.4	20,892	1.8	50,907	3.7
Good current	57,161	5.6	32,490	2.8	77,695	5.8
Midway	115,600	11.4	76,333	6.5	145,361	11.0
Streaky No. 1	21,385	2.1	14,460	1.2	15,914	1.2
Streaky No. 2	23,271	2.3	26,651	2.3	36,998	2.8
Streaky No. 3	8,976	0.9	9,623	0.8	25,491	2.0
Current	148,650	14.7	128,000	10.9	214,696	16.5
Good fair	110,132	10.9	131,499	11.2	41,673	3.3
Seconds	40,009	4.0	42,678	3.7	23,423	1.8
Fair	140,321	13.9	204,749	17.4	148,558	11.6
Brown	24,964	2.5	26,227	2.2	162,715	12.8
Medium	46,759	4.6	79,481	6.8	59,245	4.8
Coarse and deat coarse	131,426	13.0	246,767	21.0	157,757	12.3
Coarse brown and deat coarse brown	65,592	6.5	87,839	7.5	73,206	5.6
Strings, tow, and damage	15,324	1.5	28,620	2.4	28,461	2.5
Total	1,011,336	100.0	1,174,664	100.0	1,291,351	100.0



Abacá inspectors grading bales.

TABLE C.—*Production (in bales) of abacá in Albay Province.*

1917.

Month.	A.	B.	C.	D.	E.	S1.	S2.	S3.	F.	G.	H.	I.	J.	K.	L.	M.	DL.	DM.	O.Y.T.	Total.
January	-----	-----	2	10	21	-----	2	2	30	477	93	186	2,846	1,411	1,547	1,120	805	406	128	8,886
February	-----	-----	-----	12	37	1	15	2	97	356	129	278	1,752	861	1,770	1,591	699	320	53	7,973
March	-----	19	108	234	254	32	30	33	533	266	299	904	4,361	2,134	2,735	1,316	1,628	995	199	16,080
April	6	26	89	297	219	34	22	24	269	218	272	879	6,097	2,210	4,883	2,294	4,889	1.948	243	24,919
May	34	75	194	435	440	49	35	18	261	86	212	717	5,070	1,425	4,659	1,614	3,038	958	175	19,495
June	128	83	277	422	318	134	44	23	296	153	263	1,040	6,946	1,945	3,676	1,207	2,637	676	270	20,538
July	33	92	190	349	356	62	39	17	336	207	347	1,259	7,246	1,779	4,012	1,410	3,041	605	180	21,460
August	35	68	136	282	392	85	59	23	350	97	259	981	7,154	2,046	3,811	1,328	1,442	281	336	19,165
September	102	144	159	414	634	129	117	40	726	182	388	1,522	8,789	2,179	1,706	451	996	333	147	19,158
October	29	28	109	289	425	41	61	46	640	196	653	2,455	8,091	2,167	697	178	358	18	274	16,755
November	9	47	187	282	370	61	38	22	358	108	412	1,422	7,404	2,215	621	133	442	173	58	14,362
December	19	29	60	197	423	20	62	18	824	258	1,050	4,789	12,345	3,275	790	234	616	167	174	25,350
Total	395	611	1,511	3,223	3,889	648	524	268	4,720	2,604	4,377	16,432	77,901	23,647	30,907	12,.776	20,591	6,880	2,237	214,141
Percentage	0.2	0.3	0.7	1.5	1.8	0.3	0.2	0.1	2.2	1.2	2.0	7.7	36.4	11.1	14.4	6.0	9.6	3.2	1.1	100

TOTAL PRODUCTION AND PERCENTAGE FOR 1916 AND 1915.

	A.	B.	C.	D.	E.	S1.	S2.	S3.	F.	G.	H.	I.	J.	K.	L.	M.	DL.	DM.	O.Y.T.	Total.
1916.																				
Bales	29	145	543	1,016	1,496	120	109	45	1,746	1,532	1,303	8,347	59,716	24,362	75,166	32,273	14,518	2,906	3,531	228,903
Percentage	-----	0.1	0.2	0.4	0.7	0.1	0.1	-----	0.8	0.7	0.6	3.6	26.1	10.6	32.8	14.1	6.3	1.3	1.5	100
1915.																				
Bales	847	1,917	5,590	6,286	4,466	358	165	116	11,149	1,803	2,008	12,610	61,974	23,654	70,976	26,013	-----	-----	3,154	233,086
Percentage	0.4	0.8	2.4	2.7	2.0	2.0	0.1	-----	4.8	0.8	0.8	5.4	26.6	10.1	30.5	11.1	-----	-----	1.3	100

TABLE D.—*Production (in bales) of abacá in Leyte Province.*

1917.

Month.	A.	B.	C.	D.	E.	S1.	S2.	S3.	F.	G.	H.	I.	J.	K.	L.	M.	DL.	DM.	O. Y. T.	Total.
January			9	180	1,169	123	380	280	2,833	804	639	3,116	3,652	3,046	4,292	1,166	171	4	1,392	23,256
February			11	233	1,783	153	605	378	3,961	1,268	882	4,327	4,264	2,812	3,966	753	80	6	1,183	26,665
March			9	282	2,064	134	722	569	5,382	1,463	1,131	5,124	4,811	3,288	4,103	770	56		1,243	31,151
April			59	663	2,687	162	905	518	6,632	1,560	1,003	5,706	5,600	3,042	5,364	936			1,542	36,379
May		11	222	1,403	4,180	321	1,156	832	7,665	1,555	878	5,159	4,318	2,042	5,252	1,009	23		758	36,786
June		2	147	1,757	6,256	401	1,300	1,054	8,415	1,336	640	4,489	3,403	1,277	3,523	688	19	2	1,094	35,803
July			43	774	4,587	354	1,360	918	8,064	1,246	584	4,766	1,872	788	3,107	677	21	10	682	29,853
August			15	645	4,863	394	1,425	1,093	9,889	1,744	740	5,122	2,087	635	1,957	282	3		1,140	32,034
September			10	556	4,866	484	1,493	993	9,589	1,102	632	3,891	1,320	834	1,315	459			347	27,891
October			7	317	3,943	381	1,345	804	9,318	1,252	823	4,524	2,562	1,117	887	291			353	27,914
November		1	7	189	2,935	264	1,225	705	8,887	1,383	697	4,747	3,243	1,247	710	65			590	26,795
December			13	427	4,367	365	1,779	1,061	12,263	1,485	788	5,223	2,909	1,293	1,102	130			845	34,050
Total		14	552	7,426	43,700	3,536	13,695	9,205	92,898	16,198	9,437	56,194	40,041	21,421	35,580	7,226	373	22	11,159	368,677
Percentage			0.1	2.0	11.9	1.0	2.7	2.5	25.2	4.4	2.6	15,2	10.9	5.8	9.7	1.9	0.1		3.0	100
TOTAL AND PERCENTAGE FOR 1916 AND 1915.																				
1916.																				
Bales		2	147	2,940	20,862	3,423	7,910	3,366	45,559	14,107	12,123	47,220	69,008	27,505	30,892	2,415	337	9	12,432	300,257
Percentage				1.0	7.0	1.1	2.7	1.1	15.2	4.7	4.0	15.7	23.0	9.2	10.3	0.8	0.1		4.1	100
1915.																				
Bales	3	124	651	7,098	38,747	8,129	9,619	4,373	61,497	18,912	13,664	50,096	38,485	9,830	1,302	277			4,341	267,147
Percentage			0.2	2.7	14.5	3.0	3.6	1.6	23.0	7.1	5.1	18.8	14.4	3.7	0.5	0.1			1.7	100

Loading abacá bales on carts, Cebú.

TABLE E.—*Production (in bales) of abacá in Camarines Province.*

1917.

Month.	A.	B.	C.	D.	E.	S1.	S2.	S3.	F.	G.	H.	I.	J.	K.	L.	M.	DL.	DM.	O. Y. T.	Total.
January	44	43	18	6	2	9	2	----	26	28	52	93	662	278	3, 020	1, 078	1, 127	781	56	7, 325
February	36	68	50	8	----	9	----	----	1	4	24	31	203	21	430	180	1, 087	853	50	3, 055
March	206	650	715	193	42	59	15	----	21	20	37	82	448	252	2, 122	890	956	1, 171	123	8, 002
April	133	774	1, 592	314	73	157	42	2	12	9	32	73	220	118	5, 013	815	1, 147	1, 233	331	9, 090
May	103	741	1, 676	591	48	165	54	6	16	12	27	110	471	248	1, 874	691	941	939	431	9, 144
June	157	904	1, 904	590	139	161	75	21	73	33	44	74	320	225	2, 034	1, 015	1, 256	757	223	10, 805
July	102	650	1, 339	513	74	125	93	29	7	2	5	24	165	66	1, 313	393	804	506	104	6, 314
August	229	619	1, 375	819	230	97	97	47	57	2	17	22	227	126	2, 283	825	1, 110	527	184	8, 893
September	47	445	1, 267	973	371	105	93	25	69	33	37	52	410	300	1, 978	747	352	150	111	7, 565
October	77	409	1, 099	1, 294	510	164	74	44	89	9	25	24	618	357	1, 883	716	204	123	127	7, 564
November	60	160	671	1, 160	636	65	82	54	187	28	73	87	762	318	1, 683	645	69	24	47	6, 811
December	31	86	748	1, 290	619	117	82	49	193	33	182	313	1, 537	599	2, 346	866	87	34	34	9, 249
Total	1, 225	5, 549	12, 454	7, 751	2, 744	1, 233	709	277	751	216	555	985	6, 043	2, 908	23, 479	8, 861	9, 140	7, 098	1, 821	93, 799
Percentage	1.3	5.9	13.3	8.3	2.9	1.3	0.8	0.3	0.8	0.2	0.6	1.1	6.5	3.1	25.0	9.5	9.8	7.4	1.9	100
TOTAL PRODUCTION AND PERCENTAGE 1916 AND 1915.																				
1916.																				
Bales	391	722	871	552	217	34	34	12	567	475	460	3, 565	13, 202	5, 441	61, 848	21, 697	23, 875	12, 735	2, 662	149, 360
Percentage	0.2	0.5	0.6	0.3	0.1	----	----	----	0.3	0.3	0.3	2.4	9.2	3.6	41.4	14.5	16.0	8.5	1.8	100
1915.																				
Bales	1, 943	4, 806	7, 530	5, 693	2, 302	777	448	60	1, 454	628	261	1, 865	7, 022	3, 029	40, 636	21, 606	----	----	1, 159	101, 219
Percentage	1.9	4.8	7.4	5.6	2.3	0.8	0.4	----	1.4	0.6	0.3	1.8	7.0	3.0	40.2	21.4	----	----	1.1	100

TABLE F.—*Production (in bales) of abacá in Sorsogon Province.*

1917.

Month.	A.	B.	C.	D.	E.	S1.	S2.	S3.	F.	G.	H.	I.	J.	K.	L.	M.	DL.	DM.	O.Y.T.	Total.
January	------	53	147	67	65	22	10	8	288	243	469	1,406	4,047	1,594	1,032	91	9	5	104	9,660
February	------	43	145	116	106	27	35	7	117	182	247	948	2,689	1,362	1,260	223	4	------	99	7,610
March	17	549	1,765	1,477	785	304	285	56	582	193	321	1,157	2,408	1,141	1,831	379	64	2	346	13,662
April	------	194	1,201	1,164	591	214	265	169	760	284	229	982	1,312	680	504	66	21	11	279	8,926
May	22	684	2,753	3,074	1,465	319	461	193	819	160	184	964	1,243	496	429	63	3	3	206	13,541
June	2	203	2,228	3,189	1,737	337	449	197	870	201	180	909	982	464	268	37	15	8	249	12,525
July	------	42	1,288	2,646	1,789	254	453	250	884	192	155	746	574	195	133	40	2	1	245	9,889
August	1	21	642	3,392	1,993	284	307	258	789	159	206	813	717	222	62	59	2	3	166	9,096
September	------	7	640	2,884	2,572	261	419	313	1,461	253	249	1,246	872	275	166	17	24	------	189	11,848
October	------	5	242	1,573	2,053	161	310	234	1,350	216	255	1,358	977	334	138	23	3	5	171	9,408
November	------	1	173	1,117	1,567	113	232	149	1,292	234	401	1,908	2,000	518	207	71	24	15	136	10,158
December	------	3	111	731	1,739	104	214	138	1,695	232	540	2,882	3,670	810	230	60	12	18	279	13,468
Total	42	1,805	11,335	20,430	16,462	2,400	3,440	1,972	10,907	2,549	3,436	15,319	21,491	8,021	6,260	1,129	183	71	2,469	129,791
Percentage	------	1.4	8.6	15.8	12.7	1.8	2.7	1.5	8.3	2.0	2.7	11.8	16.6	6.2	4.8	0.9	0.2	0.1	1.9	100
TOTAL PRODUCTION AND PERCENTAGE FOR 1916 AND 1915.																				
1916.																				
Bales	3	94	225	333	2,164	62	171	47	10,119	5,546	8,061	33,434	50,808	18,648	5,403	383	3	2	2,072	137,578
Percentage	------	------	0.2	0.3	1.6	------	0.1	------	7.4	4.0	5.9	24.3	36.9	13.6	3.9	0.3	------	------	1.5	100
1915.																				
Bales	79	1,923	4,155	5,704	10,223	721	883	191	20,013	7,908	6,805	29,863	25,865	4,569	2,193	386	------	------	1,890	123,374
Percentage	0.1	1.5	3.4	4.6	8.3	0.6	0.7	0.2	16.2	6.4	5.5	24.2	21.0	3.7	1.8	0.3	------	------	1.5	100

TABLE G.—*Production (in bales) of abacá in Samar Province.*

1917.

Month.	A.	B.	C.	D.	E.	S1.	S2.	S3.	F.	G.	H.	I.	J.	K.	L.	M.	DL.	DM.	O. Y. T.	Total.
January	1	1	17	167	845	270	831	631	2,692	1,248	301	2,451	769	65	54	9			225	10,577
February	2	4	24	139	773	123	501	515	2,281	961	241	1,892	714	229	61	7			241	8,708
March		2	17	192	1,247	163	833	852	4,040	1,271	286	3,185	885	105	75	9			364	13,526
April			15	145	982	151	735	849	3,363	1,294	370	2,544	701	123	78	10			301	11,661
May			13	187	1,310	162	838	988	4,065	1,115	421	2,960	976	29	47	1			299	13,411
June		3	31	326	1,499	163	793	1,125	4,169	1,104	512	3,015	1,143	53	35	6			308	14,285
July		3	80	572	2,081	150	583	751	3,373	613	219	1,866	541	12	12				358	11,219
August	28	78	119	612	2,110	202	541	815	3,140	1,014	381	1,719	768	56	6	2			346	11,937
September		1	42	665	2,348	186	738	685	3,570	393	269	1,605	537	27	5				242	11,313
October			22	382	1,843	147	451	356	2,332	267	77	757	187						48	6,869
November		1	14	747	2,981	120	821	1,092	4,619	607	352	2,739	648	1					320	15,062
December		2	10	412	2,301	80	562	732	6,669	486	196	2,289	425						304	15,468
Total	31	95	404	4,546	20,320	1,917	8,227	9,396	41,313	10,373	3,625	27,022	8,294	700	373	44			3,356	140,036
Percentage		0.1	0.3	3.2	14.5	1.4	5.9	6.7	29.5	7.4	2.6	19.3	5.9	0.5	0.3				2.4	100
TOTAL PRODUCTION AND PERCENTAGE FOR 1916 AND 1915.																				
1916.																				
Bales	5	51	852	4,295	16,257	5,281	14,215	4,693	33,923	16,036	2,749	22,257	4,118	681	168	92	6	15	2,698	128,392
Percentage			0.7	3.4	12.7	4.1	11.1	3.7	26.4	12.5	2.2	17.3	3.2	0.5	0.1				2.1	100
1915.																				
Bales	21	493	3,116	12,779	25,803	1,696	8,528	2,678	24,705	5,518	747	3,216	415	87	194	95			751	95,242
Percentage		0.5	3.3	13.4	27.1	6.4	8.9	2.8	25.9	5.8	0.8	3.4	0.4	0.1	0.2	.1			0.8	100

TABLE H.—*Production (in bales) of abacá in North Mindanao Provinces.*

1917.

Month.	A.	B.	C.	D.	E.	S1.	S2.	S3.	F.	G.	H.	I.	J.	K.	L.	M.	DL.	DM.	O. Y. T.	Total.
January			11	167	980	44	174	91	1,619	330	90	932	447	137	1,174	764	848	549	342	8,699
February			18	189	1,034	74	213	124	2,223	425	129	1,460	531	125	682	596	322	168	367	8,680
March			3	164	1,391	25	231	119	2,718	293	83	1,130	308	118	995	647	1,074	479	279	10,057
April			6	199	1,732	45	258	176	2,878	399	106	1,379	492	75	679	475	457	258	179	9,793
May			23	594	3,820	159	568	208	3,394	450	69	1,201	469	120	929	509	556	277	261	13,607
June			26	582	3,316	218	693	363	5,208	723	212	2,172	651	211	2,069	1,582	1,866	1,319	548	22,059
July			9	390	2,115	112	353	219	3,100	529	161	2,000	693	119	689	601	1,086	535	269	12,980
August		1	20	438	2,758	183	640	324	3,774	806	190	2,444	963	248	2,141	1,182	1,782	805	556	19,255
September			13	476	3,280	174	628	356	4,602	695	175	2,679	913	224	1,965	827	826	272	325	18,430
October			9	387	2,105	96	360	229	2,901	509	195	2,672	913	181	1,150	609	364	150	197	13,027
November			10	250	1,731	104	388	184	2,933	491	161	2,348	563	148	923	451	194	52	262	11,193
December			17	452	2,566	129	604	131	2,009	357	65	600	333	189	1,444	723	201	111	166	10,097
Total		1	165	4,288	27,128	1,363	5,110	2,524	37,359	6,007	1,636	21,017	6,276	1,895	14,840	8,966	9,576	4,975	3,751	157,977
Percentage			0.2	2.7	17.2	0.9	3.2	1.6	23.7	3.8	1.0	13.3	4.6	1.2	9.4	5.7	6.1	3.1	2.4	100
TOTAL PRODUCTION AND PERCENTAGE FOR 1916 AND 1915.																				
1916.																				
Bales	1	9	395	4,541	17,151	1,512	2,357	1,071	21,592	3,340	1,237	11,304	5,993	2,133	10,299	4,848	4,586	1,873	2,914	97,156
Percentage			0.4	4.7	17.7	1.6	2.4	1.1	22.2	3.4	1.3	11.6	6.2	2.2	10.6	5.0	4.7	1.9	3.0	100
1915.																				
Bales		34	621	5,841	20,451	2,057	2,551	1,215	19,668	3,514	1,102	9,774	5,534	4,178	5,396	9,171			1,833	92,940
Percentage			0.7	6.2	22.0	2.2	2.7	1.3	21.2	3.8	1.2	10.5	6.0	4.5	5.8	9.9			2.0	100

TABLE I.—*Production (in bales) of abacá in South Mindanao Provinces.*

1917.

Month.	A.	B.	C.	D.	E.	SI.	S2.	S3.	F.	G.	H.	I.	J.	K.	L.	M.	DL.	DM.	O. Y. T.	Total.
January	82	370	774	744	583	168	129	21	721	88	2	539	42	----	----	----	----	----	86	4,349
February	34	109	457	792	594	121	86	11	506	50	1	218	7	----	----	----	----	----	76	3,062
March	59	337	1,065	1,272	865	295	300	72	828	87	----	286	2	----	----	----	----	----	71	5,539
April	45	302	970	1,209	638	157	211	60	748	206	5	744	11	----	----	----	----	----	108	5,414
May	83	347	1,287	1,657	1,353	203	251	68	1,068	235	2	531	13	----	----	----	----	----	134	7,232
June	53	175	803	1,767	1,973	194	384	97	2,075	226	4	746	13	3	----	----	----	----	150	8,663
July	148	466	1,212	1,432	1,176	181	204	64	1,245	108	4	533	2	----	----	----	----	----	130	6,905
August	156	306	709	1,154	1,201	139	188	81	1,305	202	6	602	11	----	----	----	----	----	126	6,186
September	104	365	1,133	1,726	1,931	216	295	144	1,780	213	8	639	2	----	----	----	----	----	162	8,718
October	125	350	879	1,483	1,457	184	287	164	1,472	267	13	741	3	----	6	2	----	----	144	7,577
November	77	248	820	1,304	1,591	238	432	214	2,027	333	17	1,168	23	1	5	1	----	----	173	8,672
December	67	193	621	1,250	1,704	236	439	285	2,514	379	33	1,254	66	16	----	----	----	----	206	9,263
Total	1,033	3,568	10,730	15,790	15,066	2,332	3,206	1,281	16,289	2,394	95	8,001	195	20	11	3	----	----	1,566	81,580
Percentage	1.3	4.4	13.1	19.4	18.5	2.9	3.9	1.6	20.0	2.9	0.1	9.8	0.2	----	----	----	----	----	1.9	100
TOTAL PRODUCTION AND PERCENTAGE FOR 1916 AND 1915.																				
1916.																				
Bales	568	2,768	7,561	8,566	9,595	1,880	1,141	274	10,036	826	161	3,702	480	134	56	11	3	----	822	48,584
Percentage	1.2	5.7	15.6	17.6	19.7	3.9	2.3	0.6	20.7	1.7	0.3	7.6	1.0	0.3	0.1	----	----	----	1.7	100
1915.																				
Bales	827	2,290	4,938	5,659	6,616	1,673	494	163	7,383	1,065	105	2,210	213	1	53	39	----	----	591	34,320
Percentage	2.4	6.7	14.7	16.5	19.3	4.9	1.4	0.5	21.5	3.1	0.3	6.4	0.6	----	0.1	0.1	----	----	1.6	100

TABLE J.—*Production (in bales) of abacá in Cavite Province.*

1917.

Month.	A.	B.	C.	D.	E.	S1.	S2.	S3.	F.	G.	H.	I.	J.	K.	L.	M.	DL.	IM.	O. Y. T.	Total.
January	287	203	111	7															39	647
February	303	233	116	10															54	716
March	537	399	350	29															47	1,362
April	448	394	256	19															25	1,142
May	398	444	472	18															54	1,386
June	427	353	306	29															141	1,256
July	280	299	243	14															54	890
August	419	489	372	42															76	1,398
September	719	699	604	61	2														95	2,180
October	245	338	224	19															74	900
November	74	76	64	15	31	16													28	304
December	154	154	181	5															10	504
Total	4,291	4,081	3,299	268	33	16													697	12,685
Percentage	33.8	32.2	26.0	2.1	0.3	0.1													5.5	100
TOTAL PRODUCTION AND PERCENTAGE FOR 1916 AND 1915.																				
1916.																				
Bales	4,600	3,096	877	67	3	16	1												333	8,993
Percentage	51.2	34.4	9.8	.7		.2													3.7	100
1915.																				
Bales	5,165	4,215	1,576	109	27	27													246	11,366
Percentage	45.4	37.1	13.9	1.0	0.2	0.2													2.2	100

TABLE K:—*Production (in bales) of abacá in Mindoro Province.*

1917.

Month.	A.	B.	C.	D.	E.	S1.	S2.	S3.	F.	G.	H.	I.	J.	K.	L.	M.	DL.	DM.	O. Y. T.	Total.
January	2	65	449	479	114	3	3	1	7										7	1,130
February	11	29	238	393	189	6	8	2	35			1							3	915
March	1	33	650	888	285	8	16	3	33	1									3	1,921
April		19	356	401	141	3	6	3	42	2		5	1							979
May		13	427	675	277	6	12	8	59	1		2								1,480
June		20	290	546	319	6	18	6	91	1	1	4							5	1,307
July		19	192	401	210	5	9	2	37	2									3	880
August		56	451	602	291	11	20	11	40		1								8	1,491
September		17	276	894	574	10	41	12	144	1									4	1,973
October		12	162	464	357	14	21	6	99										4	1,139
November			46	258	169	4	9	1	33										2	522
December		1	101	725	639	8	36	16	186											1,712
Total	14	284	3,638	6,726	3,565	84	199	71	806	8	2	12	1						39	15,449
Percentage	0.1	1.8	23.5	43.5	23.1	0.5	1.3	0.5	5.2	0.1		0.1							0.3	100

TOTAL PRODUCTION AND PERCENTAGE FOR 1916 AND 1915.

Month.	A.	B.	C.	D.	E.	S1.	S2.	S3.	F.	G.	H.	I.	J.	K.	L.	M.	DL.	DM.	O. Y. T.	Total.
1916.																				
Bales	10	1,035	5,238	4,440	1,157	97	61	12	115	1		7							28	12,201
Percentage	0.1	8.5	42.9	36.4	9.5	0.8	0.5	0.1	0.9			0.1							0.2	100
1915.																				
Bales	7	565	3,398	2,974	876	22	46	10	325	46		16	18		2				7	8,312
Percentage		6.8	40.9	35.8	10.5	0.3	0.6	0.1	3.9	0.6		0.2	0.2							100

TABLE L.—*Production (in bales) of abacá in Tayabas Province.*

1917.

Month.	A.	B.	C.	D.	E.	S1.	S2.	S3.	F.	G.	H.	I.	J.	K.	L.	M.	DL.	DM.	O.Y.T.	Total.
January												1	7	2	44	10	197	109	5	375
February				1	1				1				1		11	37	109	103	13	277
March													8	1	24	8	150	69	19	279
April		5	9	10	2				9	8		11	2		48	43	99	93	5	344
May			19	15	8	2	2		1	1		3	5	1	198	38	378	207	8	886
June		2	17	40	13				5	1		1	14	1	253	33	371	183	4	938
July		2	26	40	3				1				4		147	39	232	116	14	624
August		1	13	12	7				3			2	8	1	60	19	100	60	1	287
September			19	22	11				3	2		3	19	2	86	20	25	19		231
October	1	12	57	36	8	1	2		15			1			23	6	6	3	5	176
November			6	25	16				7	2		1	8	1	25	8	29	30		158
December			2	18	19	1	1		11	1			5		25	5	13	10	1	112
Total	1	22	163	219	88	4	5		56	15		23	81	9	944	266	1,709	1,002	75	4,687
Percentage		0.5	3.6	4.7	1.9	0.1	0.1		1.2	0.3		0.5	1.7	0.2	20.1	5.7	36.4	21.4	1.6	100
TOTAL PRODUCTION AND PERCENTAGE FOR 1916 AND 1915.																				
1916.																				
Bales		3	11	28	35	7	6		76	29		117	425	70	5,650	856	3,539	1,086	50	11,988
Percentage				0.2	0.3				0.6	0.2		1.0	3.5	0.6	47.1	7.1	30.0	9.0	0.4	100
1915.																				
Bales		286	1,063	1,393	842	15	6		282	51		11	88	4	4,608	833			4	9,486
Percentage		3.0	11.2	14.7	8.9	0.2			3.0	0.5		0.1	0.8		48.7	8.9				100

TABLE M.—*Production (in bales) of abacá in Cebu Province.*

1917.

Month.	A.	B.	C.	D.	E.	S1.	S2.	S3.	F.	G.	H.	I.	J.	K.	L.	M.	DL.	DM.	O.Y. T.	Total.
January				39	315	116	65	1	343	6		59	9						1	954
February			1	101	772	154	88	7	630	22		112	5						3	1,895
March				68	563	123	61	4	422	8		76	12	2					5	1,344
April				127	601	147	84	10	342	9	1	87	16	1					3	1,428
May			2	131	997	310	163	22	550	36	8	112	32	3					12	2,378
June				83	951	175	85	18	569	12	3	83	16	4					14	2,013
July			4	87	749	164	130	28	544	29	2	91	24	8					3	1,863
August				73	678	143	11	28	494	37	2	129	20	3					3	1,724
September				34	475	114	69	17	363	21		79	5						22	1,199
October				16	245	81	38	13	176	4		29	3		8	4	1		2	620
November			1	16	199	63	32	14	156	17		38	2						3	541
December				17	269	87	41	13	217	12		41	5						3	705
Total			8	792	6,814	1,677	970	175	4,806	213	16	936	149	21	8	4	1		74	16,664
Percentage				4.8	40.9	10.1	5.8	1.1	28.8	1.3	0.1	5.6	0.9	0.1					0.5	100
TOTAL PRODUCTION AND PERCENTAGE FOR 1916 AND 1915.																				
1916.																				
Bales			40	1,325	4,163	1,511	220	25	1,744	162	45	372	171	13	4				127	9,922
Percentage			0.4	13.4	42.0	15.2	2.2	0.3	17.6	1.6	0.5	3.7	1.7	0.1					1.3	100
1915.																				
Bales		17	143	1,447	3,183	1,227	309	123	977	261	161	221	147	285	209	450			611	9,771
Percentage		0.2	1.5	14.8	32.6	12.6	3.1	1.3	10.0	2.6	1.7	2.3	1.5	2.9	2.1	4.6			6.2	100

TABLE N.—*Production (in bales) of abacá in various provinces.*

1917.

Month.	A.	B.	C.	D.	E.	S1.	S2.	S3.	F.	G.	H.	I.	J.	K.	L.	M.	DL.	DM.	O.Y.T.	Total.
January	142	352	451	466	296	47	55	15	209	33	10	116	78	19	14	79	233	395	118	3, 128
February	169	394	504	576	431	59	60	10	290	76	19	191	135	41	64	194	786	560	83	4, 642
March	189	542	767	674	656	58	65	22	509	94	23	279	146	34	61	101	203	332	78	4, 742
April	155	441	675	523	440	39	43	13	330	98	21	261	167	56	125	392	813	652	73	5, 317
May	188	462	702	656	506	62	106	26	495	197	47	432	237	81	61	360	387	311	100	5, 416
June	132	437	823	689	537	76	96	31	513	118	27	258	73	43	122	572	989	1, 361	153	7, 050
July	162	434	681	694	544	56	76	26	447	92	18	250	114	33	42	335	420	335	65	4, 824
August	206	398	618	489	447	57	79	27	400	87	12	173	76	49	228	856	1, 336	614	107	6, 259
September	366	720	706	507	581	82	107	55	503	91	24	169	57	66	241	680	737	178	140	6, 010
October	197	257	308	330	375	39	64	24	318	60	11	154	57	40	79	252	107	66	59	2, 797
November	45	95	232	341	357	63	71	36	325	72	11	114	50	33	206	497	356	302	124	3, 330
December	97	109	176	291	473	66	91	37	452	78	21	220	53	38	202	317	69	43	117	2, 950
Total	2, 048	4, 641	6, 643	6, 236	5, 552	704	913	322	4, 791	1, 096	244	2, 617	1, 243	533	1, 445	4, 635	6, 436	5, 149	1, 217	56, 465
Percentage	3. 6	8. 2	11. 8	11. 1	9. 8	1. 3	1. 6	0. 6	8. 5	1. 9	0. 4	4. 6	2. 2	0. 9	2. 6	8. 2	11. 4	9. 1	2. 2	100

TOTAL PRODUCTION AND PERCENTAGE FOR 1916 AND 1915.

Month.	A.	B.	C.	D.	E.	S1.	S2.	S3.	F.	G.	H.	I.	J.	K.	L.	M.	DL.	DM.	O.Y.T.	Total.
1916.																				
Bales	1, 718	3, 114	4, 132	4, 387	3, 233	517	426	78	2, 523	624	88	1, 164	828	494	5, 532	4, 100	4, 882	2, 538	951	41, 329
Percentage	4. 2	7. 5	10. 0	10. 6	7. 8	1. 3	1. 0	0. 2	6. 1	1. 5	0. 2	2. 8	2. 0	1. 2	13. 4	9. 9	11. 8	6. 2	2. 3	100
1915.																				
Bales	786	1, 145	1, 542	2, 178	2, 064	233	221	48	1, 197	303	111	250	557	1, 122	5, 857	6, 722	-----	-----	737	25, 073
Percentage	3. 1	4. 6	6. 1	8. 7	8. 2	0. 9	0. 9	0. 1	4. 8	1. 2	0. 5	1. 0	2. 2	4. 4	23. 4	26. 8	-----	-----	3. 1	100

TABLE O.—*Production (in bales) of maguey (cantala), retted, in the Philippine Islands.*

1917.

District of production.	Standard grades.				
	MGY-1.	MGY-2.	MGY-3.	MGY-D.	Total.
Ilocos	255	22,688	18,808	5,001	46,752
Cebu	5,865	40,761	15,351	1,149	63,126
Bohol	21	1,260	1,532	72	2,885
Various	1	27	50	15	93
Total	6,142	64,736	35,741	6,237	112,856
Percentage	5.4	57.4	31.7	5.5	100
TOTAL PRODUCTION AND PERCENTAGE FOR 1916 AND 1915.					
1916.					
Bales	10,065	69,783	42,930	6,485	129,263
Percentage	7.8	54.0	33.2	5.0	100
1915.					
Bales	3,162	32,497	21,035	3,246	59,940
Percentage	5.3	54.2	35.1	5.4	100

TABLE P.—*Production (in bales) of maguey (cantala), retted, in the Philippine Islands.*

1917.

Month.	MGY-1.	MGY-2.	MGY-3.	MGY-D.	Total.
January	869	6,400	2,980	403	10,652
February	625	7,366	3,834	1,096	12,921
March	582	9,093	6,234	1,146	17,055
April	521	4,326	2,404	386	7,637
May	471	7,603	5,106	1,215	14,395
June	444	8,721	4,610	764	14,539
July	343	3,913	2,182	235	6,673
August	847	4,144	1,641	186	6,818
September	403	3,519	2,121	248	6,291
October	344	2,713	1,625	231	4,913
November	222	2,619	1,318	106	4,265
December	471	4,319	1,686	221	6,697
Total	6,142	64,736	35,741	6,237	112,856
Percentage	6.0	58.0	31.1	4.9	100

TABLE Q.—*Production (in bales) of maguey (cantala), retted, in Ilocos Provinces.*

1917.

Month.	MGY-1.	MGY-2.	MGY-3.	MGY-D.	Total.
January	31	2,394	1,465	287	4,177
February	31	3,226	2,294	968	6,537
March	69	5,614	4,765	1,029	11,477
April	4	1,023	1,253	267	2,547
May	10	3,132	3,178	1,047	7,367
June	32	5,242	3,594	693	9,561
July	-------	247	360	86	693
August	-------	652	461	100	1,213
September	1	379	500	148	1,028
October	3	46	162	142	353
November	1	55	191	45	292
December	73	678	585	171	1,507
Total	255	22,688	18,808	5,001	46,752
Percentage	0.6	48.5	40.2	10.7	100
TOTAL PRODUCTION AND PERCENTAGE FOR 1916 AND 1915.					
1916.					
Bales	3,865	33,460	24,789	4,863	66,977
Percentage	5.8	49.9	37.0	7.3	100
1915.					
Bales	1,175	16,069	7,257	2,309	26,810
Percentage	4.4	59.9	27.1	8.6	100

During 1915, there were produced 14 bales of strings and tow.

TABLE R.—*Production (in bales) of maguey (cantala), retted, in Cebu Province.*

1917.

Month.	MGY-1.	MGY-2.	MGY-3.	MGY-D.	Total.
January	831	3,878	1,444	114	6,267
February	594	3,933	1,343	105	5,975
March	513	3,374	1,313	108	5,308
April	515	3,212	1,050	108	4,885
May	456	4,313	1,785	162	6,716
June	408	3,351	874	59	4,692
July	340	3,580	1,707	140	5,767
August	847	3,408	1,089	84	5,428
September	401	3,060	1,469	96	5,026
October	341	2,627	1,317	80	4,365
November	221	2,478	952	44	4,365
December	398	3,547	1,008	49	3,695
Total	5,865	40,761	15,351	1,149	63,126
Percentage	9.3	64.6	24.3	1.8	100
TOTAL PRODUCTION AND PERCENTAGE FOR 1916 AND 1915.					
1916.					
Bales	5,972	33,591	16,659	1,546	57,768
Percentage	10.3	58.3	28.8	2.6	100
1915.					
Bales	1,951	15,642	13,065	865	31,523
Percentage	6.2	49.6	41.4	2.8	100

TABLE S.—*Production (in bales) of maguey (cantala), retted, in Bohol Province.*

1917.

Month.	MGY-1.	MGY-2.	MGY-3.	MGY-D.	Total.
January	6	113	66	1	186
February		207	197	5	409
March		105	156	9	270
April	2	90	85	5	182
May	5	155	140	6	306
June	4	124	123	4	255
July	3	86	115	9	213
August		84	90	2	176
September	1	80	152	4	237
October		40	146	9	195
November		86	175	17	278
December		90	87	1	178
Total	21	1,260	1,532	72	2,885
Percentage	0.7	43.7	53.1	2.5	100
TOTAL PRODUCTION AND PERCENTAGE FOR 1916 AND 1915.					
1916.					
Bales	223	2,592	1,417	66	4,298
Percentage	5.1	60.2	33.2	1.5	100
1915.					
Bales	20	493	478	41	1,032
Percentage	1.9	47.8	46.3	4.0	100

TABLE T.—*Production (in bales) of maguey (cantala), retted, in various provinces.*

1917.

Month.	MGY-1.	MGY-2.	MGY-3.	MGY-D.	Total.
January	1	15	5	1	22
February					
March					
April		1	16	6	23
May		3	3		6
June		4	19	8	31
July					
August			1		1
September					
October					
November					
December		4	6		10
Total	1	27	50	15	93
Percentage	1.1	29.0	53.8	16.1	100
TOTAL PRODUCTION AND PERCENTAGE FOR 1916 AND 1915.					
1916.					
Bales	5	140	65	10	220
Percentage	2.3	63.6	29.6	4.5	100
1915.					
Bales	16	293	235	17	561
Percentage	2.9	52.2	41.9	3.0	100

FURTHER DATA ON THE CITRUS CANKER AFFECTION OF THE CITRUS SPECIES AND VARIETIES AT LAMAO.

By H. ATHERTON LEE, *Assistant Pathologist, Bureau of Plant Industry, United States Department of Agriculture.*

In September, 1917, investigations were begun by the writer at Lamao upon possible control methods for citrus canker. At the commencement of these investigations the degree of citrus canker affection for each tree was recorded. In view of the previous publications ([1]) of Mr. P. J. Wester, Horticulturist in charge of Lamao Experiment Station, on this subject the data so collected is presented to supplement his observations. This tabulation should have a special significance since it shows the degree of canker affection in September, the middle of the rainy season.

Slight variations from Wester's form of tabulation have seemed advisable. Thus the heading "resistant" has been substituted for "immune," since it is questionable whether an absolutely naturally occuring immune species of *Citrus* exists. However there are many varieties of certain *Citrus* species that can be properly considered resistant. The heading "none observed" has been sustituted for the heading "nearly immune" since it is a little more definite and descriptive.

The revisions in nomenclature suggested by W. T. Swingle ([2]) and by E. D. Merrill ([3]) are used in this tabulation.

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[1] P. J. Wester: Additional Observations on the Citrus Fruits in the Philippines. The Philippine Agricultural Review 10 (1917) 104–115.

P. J. Wester: Notes on Citrus Canker Affection at the Lamao Experiment Station. The Philippine Agricultural Review, 10 (1917), 252–260.

[2] For the revision of *Citrus* species by Swingle see the Standard Cyclopedia of Horticulture, edited by L. H. Bailey, MacMillan Co. (1914), Vol. II, pp. 780–785.

[3] Merrill E. D., An Interpretation of Rumphius's Herbarium Amboinense. Bureau of Science Publication No. 9, Manila, P. I. (1917).

P. I. No.—	Species and variety.	Canker affection. Severe.	Medium.	Slight.	None observed.	Resistant.	Remarks.
740	*Citrus sinensis*		v				
966	do	v					
1728	do			v			
2340	do		v				
2365	do				v		
2568	do			v			
2569	do			v			
3660	do	v					
3843	do			v			
5699	do	v					
706	*Citrus sinensis*, "Bahia"				v		
1720	do			v			
2698	*Citrus sinensis*, "Boone"		v				
4117	*Citrus sinensis*, "Brown"		v				
2695	do	v					
4124	*Citrus sinensis*, "Carleton"		v				
4119	*Citrus sinensis*, "Dugat"		v				
4120	*Citrus sinensis*, "Duroi"			v			
3886	do				v		
2689	*Citrus sinensis*, "Enterprise"		v				
2685	*Citrus sinensis*, "Everbearing."		v				
1260	*Citrus sinensis*, "Excelsior"			v			
4126	*Citrus sinensis*, "Foster"		v				
1701	*Citrus sinensis*, "Holdfast"			v			
2691	*Citrus sinensis*, "Homosassa"				v		
1258	*Citrus sinensis*, "Jaffa"			v			This tree should probably be considered resistant.
1719	do			v			Do.
1637	do			v			Do.
56	do			v			Do.
1714	*Citrus sinensis*, "Larantta"		v				
4123	*Citrus sinensis*, "Magnum Bonum."		v				
1259	*Citrus sinensis*, "Malta Blood."			v			
2697	do	v					
2694	*Citrus sinensis*, "Majorca"			v			
1743	*Citrus sinensis*, "Mediterranean."				v		Growing condition poor.
1705	do		v				
1277	*Citrus sinensis*, "Seville"	v					
1270	*Citrus sinensis*, "St. Michael"			v			Tree growing poorly.
1742	*Citrus sinensis*, "Navelencia."				v		
1635	*Citrus sinensis*, "Pineapple"		v				
2686	*Citrus sinensis*, "Pineapple"	v					
5177	*Citrus sinensis*, "Pongkam"		v				
1917	*Citrus sinensis*, "Ruby"				v		
1639	do				v		
1273	*Citrus sinensis*, "Satsumamikan."		v				
2696	*Citrus sinensis*, "Tardiff"		v				
1706	*Citrus sinensis*, "Valencia			v			
51	do			v			
1266	*Citrus sinensis*, "Whittaker"		v				
1715	*Citrus sinensis*, "White Siletta."		v				
1744	*Citrus sinensis*, "Washington Navel."		v				
2114	*Citrus sinensis*, "Sawyer's Navel."			v			
1711	*Citrus sinensis*, "Washington's Navel."			v			
1636	do			v			
741-3-4	*Citrus maxima*			v			
750	do	v					
891	do		v				
893	do	v					
897	do			v			

P. I. No.—	Species and variety.	Canker affection. Severe.	Medium.	Slight.	None observed.	Resistant.	Remarks.
899	*Citrus maxima*	v					
2257-1-2-3-4	do		v				
2265	do	v					
2461-1-3-4-6-7	do	v					
2503	do			v			
3657	do				v		Growing condition poor.
3661	do				v		Possibly resistant.
3662	do			v			Slowly affected.
3384	do			v			
5181	do				v		Growing condition poor, not necessarily resistant.
5699-6	do			v			
1995	*Citrus maxima*, "Bangkok"		v				
1633	*Citrus maxima*, "Case"		v				Pink pummelo.
2687	*Citrus maxima*, "Duncan"	v					
1333	*Citrus maxima*, "Ellen"	v					
2690	*Citrus maxima*, "Marsh"	v					
1631	do	v					
1707	*Citrus maxima*, "McCarty"	v					
3882	do	v					
4121	do	v					
3876	*Citrus maxima*, "Nakoin"		v				
1334	*Citrus maxima*, "Pernambuco."	v					
4125	*Citrus maxima*, "Royal"	v					
3389	*Citrus maxima*, "Siam"					v	
5152	do		v				
3442	*Citrus maxima*, "Sinsemi"	v					
1632	*Citrus maxima*, "Triumph"		v				
1713	do		v				
3391	*Citrus maxima*, "Boyle"		v				
3392	*Citrus maxima*, "Yugelar"		v				
4118	*Citrus maxima*, "Walter's"	v					
1618	*Citrus maxima*, "Sampson"	v					
1948	do		v				
3885	do		v				
3102	do			v			
741-5	*Citrus excelsa*			v			
741-12-21	do		v				
741-16-18-19-20	do				v		
833	do				v		
833-1-2-3-4	do					v	
835	do		v				
853-1-2-3-4-5-6	do		v				
1727-A	do			v			Infections largely at wounds.
1727-B	do					v	One individual apparently resistant.
3388	*Citrus* sp. near *excelsa*		v				
3841	do		v				
3844	do	v					
970-1-2	*Citrus excelsa* var. *davaoensis*		v				
970-6	do		v				
1257	*Fortunella japonica*					v	
741-11	*Citrus aurantifolia*	v					
741-15	do	v					
901	do	v					
902	do	v					
958	do	v					
1708	*Citrus aurantifolia*, "Tahiti"		v				
4122	do				v		
5163	do		v				
5184	*Citrus aurantifolia*, "Kusaie"				v		Growing condition very poor.
3669	*Citrus aurantifolia*, "Everglade."	v					
3670	*Citrus aurantifolia*, "Trinidad."		v				
2882	*Citrus aurantifolia*, "Pati China."		v				

P. I. No.—	Species and variety.	Canker affection.					Remarks.
		Severe.	Medium.	Slight	None observed.	Resistant.	
741-10	*Citrus aurantifolia*, var. *aromatica*.		v				
897-5	do	v					
1749	do	v					
2498-2-4	do	v					
2182	do		v				
2500-1	do		v				
691	*Citrus limonia*, "Belair"			v			
692	*Citrus limonia*, "Villa Franca."				v		Growing condition poor.
708	*Citrus limonia*, "Lisbon"	v					
1634	*Citrus limonia*, "Valencia"				v		
1642	*Cirtus limonia*, "Clarke"				v		Growing condition very poor.
1702	*Citrus limonia*, "Villa Franca."			v			Do.
1703	*Citrus limonia*, "Lisbon variegated."				v		Do.
1704	*Citrus limonia*, "Bengal"				v		
1710	*Citrus limonia*, "Sicily"				v		Do.
4804	*Citrus limonia*, "African		v				
1712	*Citrus limonia*, "Thornless"				v		Do.
1723	*Citrus limonia*, "Messina"		v				
3675	*Cirtus limonia*, "Rough"			v			
875	do				v		
959	do	v					
3655	*Citrus* sp. near *limonia*	v					
790-2-3-4-5-6	*Citrus hystrix*				v		
807-5-6-7-8-9	do	v					
834-5-6-7-8	do				v		
834-9-10	do				v		
2570	do			v			Believed to be resistant.
3668	do					v	Do.
2494	do		v				
4214	do	v					
4225	do	v					
4822	do	v					
5165	do	v					
5699-11	do	v					
2524	*Citrus hystrix* var. *boholensis*				v		
3656	do		v				
3673-5-6	*Citrus hystrix* var. *torosa*	v					
2535	do		v				
27-3-4-12-15-16-17.	*Citrus medica*				v		
790-7	do				v		
1278	*Citrus medica*, "Finger"		v				
1716	do		v				
3836	*Citrus medica*, *sarcodactylis*					v	
4739	do		v				
2264	*Citrus* sp. near *medica*		v				
2183	do	v					
1010	do	v					
848	do	v					
19-7	*Citrus medica*				v		
19-6	do				v		
2384	do		v				
5699-4	do				v		
2372-1-2-3-4	*Citrus macrophylla*	v					
741-9	*Citrus mitis*				v		
741-14	do				v		
1718	do				v		
2332	do					v	
2355	do					v	
2513	do					v	
5699-2	do				v		
2502	*Citrus micrantha*			v			
1981	do				v		Growing condition poor.
5699	do	v					

P. I. No.—	Species and variety.	Canker affection.					Remarks.
		Severe.	Medium.	Slight.	None observed.	Resistant.	
4821	*Citrus micrantha*, var. *microcarpa*.		v				
3659	do		v				
3658	*Citrus longispina*		v				
1913-1-2-3-4	*Citrus nobilis*		v				
2469-1-2-3-4	do			v			
2527-1-2-3-4	do			v			
1256	*Citrus nobilis*, "Ladu"				v		
1261	*Citrus nobilis*, "Mandarin"			v			
1262	*Citrus nobilis*, "Suntara"				v		Growing condition poor.
1263	*Citrus nobilis*, "Sikkim"				v		Not actively growing.
1265	*Citrus nobilis*, "China"				v		
1267	*Citrus nobilis*, "Szinkom"			v			Believed to be truly resistant.
1271	*Citrus nobilis*, "Kishiu"			v			Do.
1272	*Citrus nobilis*, "Konda Narun"			v			Do.
1275	*Citrus nobilis*, "Unshiu"		v				
1276	*Citrus nobilis*, "Suntara Nagpur."				v		
1335	*Citrus nobilis*, "Oneco"				v		
1918	*Citrus nobilis*, "Dancy"			v			
2693	*Citrus nobilis*, "King"				v		
3883	do				v		
2984	do			v			
5142	do			v			
5173	*Citrus nobilis* var. *papillaris*				v		
744	*Citrus nobilis*, "Tizon"				v		
745	do				v		
2496	*Citrus pseudolimonum*	v					
4226	do	v					
2049	*Citrus southwickii*			v			
1264	*Citrus aurantium*,	v					
1638	*Citrus aurantium*, "Japanese Orange."					v	Do.
2662	*Citrus aurantium*, "Bigaradia."		v				
2385	do			v			
2511	do			v			
892-5-6	*Citrus webberii*	v					
892-7	do			v			
896	do			v			
2066	do				v		Growing condition poor.
2363-1-2-3-4	do			v			
897-4	do		v				
2266	*Citrus webberii*, var. *montana*				v		
5699-7	do	v					
3383	*Citrus* sp. near *webberii*	v					

In the above tabulation attention should be called to the susceptibility of many of the varieties listed as immune in the previous observations. Most noteworthy of these are introductions number 2340, number 3843 and number 2685 of *Citrus sinensis*, the last being the American "Everbearing" variety. The "Yugelar," number 3392, a variety of *Citrus maxima* has also proven to be very susceptible in this last observation.

There are on the other hand many varieties worthy of note as being apparently capable of maturing their fruits without citrus canker affection. Among the varieties of orange (*Citrus

sinensis) the "Jaffa," the "Ruby," the "St. Michael" and the "Valencia" are but slightly attacked and fruits become cankered in a comparatively small percentage of cases. It will be observed that these are all Mediterranean varieties and the slight susceptibility of this group has been pointed out previously by other investigators. The "Siam" variety of *Citrus maxima* is the only pummelo under observation which gives any promise of being resistant. All of the numerous fruits born by this variety have been free of canker and in addition were of excellent quality. This variety is one of Mr. H. H. Boyle's introductions from Siam. There is also one individual of *Citrus excelsa,* having the number 1727, which appears to be resistant. Another *Citrus excelsa* introduction, number 3844, has previously been reported as immune but in this observation has shown itself to be subject to severe infection.

The kumquat (*Fortunella japonica*) is highly resistant and might almost be considered immune, since no naturally occuring cankers have even been observed upon it.

Of the lime (*Citrus aurantifolia*) varieties, the "Tahiti," as pointed out by Wester, is but slightly affected by citrus canker. In describing this absence of susceptibility the word "resistant" is not applicable, for the foliage is affected and at times abundantly. The term "slowly affected" is perhaps more nearly applicable. The "Tahiti" however is looked upon as a variety which can be grown sucessfully, free from citrus canker. This is all the more peculiar since other lime varieties commonly are very susceptible and are comparable in this regard to the grapefruit varieties.

The listing of many of the lemon varieties under "none observed" in the present tabulation and under "immune" in the early papers leads to an erroneous conclusion unless the condition of these trees be stated. These particular lemon trees were in a very poor growing condition, putting out no new leaves and in fact becoming almost leafless from the shedding of the old foliage. Subsequent cultural methods have resulted in a betterment of the growing condition and with this improvement in growth the trees have been observed to be readily susceptible. None of the American grown varieties of *Citrus limonia* can be considered resistant.

Varieties numbered 2570 and 3668 of *Citrus hystrix* so far are free from canker and may be resistant. Number 5165 reported in April as immune was observed in September to be severely affected.

Individuals of true citron *"Citrus medica,"* represented by individuals numbered 27,790, 3836, 19–7 19–6 and 5699 may undoubtedly be considered as canker resistant. Where, however, apparent relationship of the *Citrus medica* varieties to *Citrus aurantifolia* exists, the individuals are frequently very susceptible.

From all the observations all individuals of calamondin (*Citrus mitis*) at Lamao may be said to be truly resistant.

Of the varieties of the Mandarin group (*Citrus nobilis*) the "Ladu," "Mandarin," "Suntara," "Sikkim, "China," "Oneco," "Dancy" and "King" are believed to be truly resistant.

The "Unshiu" is intentionally left from this list since it is also found at Los Baños and is there very susceptible to canker. Nevertheless the "Unshiu" strains are widely grown in Japan and as grown there are decidedly resistant. The Philippine varieties of *Citrus nobilis* are frequently spiny and such spines cause punctures in the leaves and fruits, at which wounds canker infection often results. The native varieties cannot therefore be considered as desirable as those Japanese varieties which have few or no spines.

Of the varieties of *Citrus aurantium* one stands out definitely as canker resistant. This is the Japanese orange number 1638. A number of individuals of this variety have been under observation for a continuous period and no cankers have ever been observed; the growing condition has at all times been good.

The individuals of Wester's *Citrus webberii* are all very susceptible to canker, being comparable to *Citrus aurantifolia* in the degree of their affection.

One other matter requires mention, the listing of the "Satsumamikan" with varieties of *Citrus sinensis.* It is questionable whether this variety properly belongs here since the fruit has many of the characteristics of the grapefruit. This variety although susceptible is somewhat similar to the "Tahiti" lime in being slowly affected by canker. The fruit is very desirable, and this variety may prove worthy of a trial as a substitute for the very susceptible American grapefruit varieties. It is possible that there may be some confusion in the naming of this variety and that this is the "Natsumikan" of Japan.

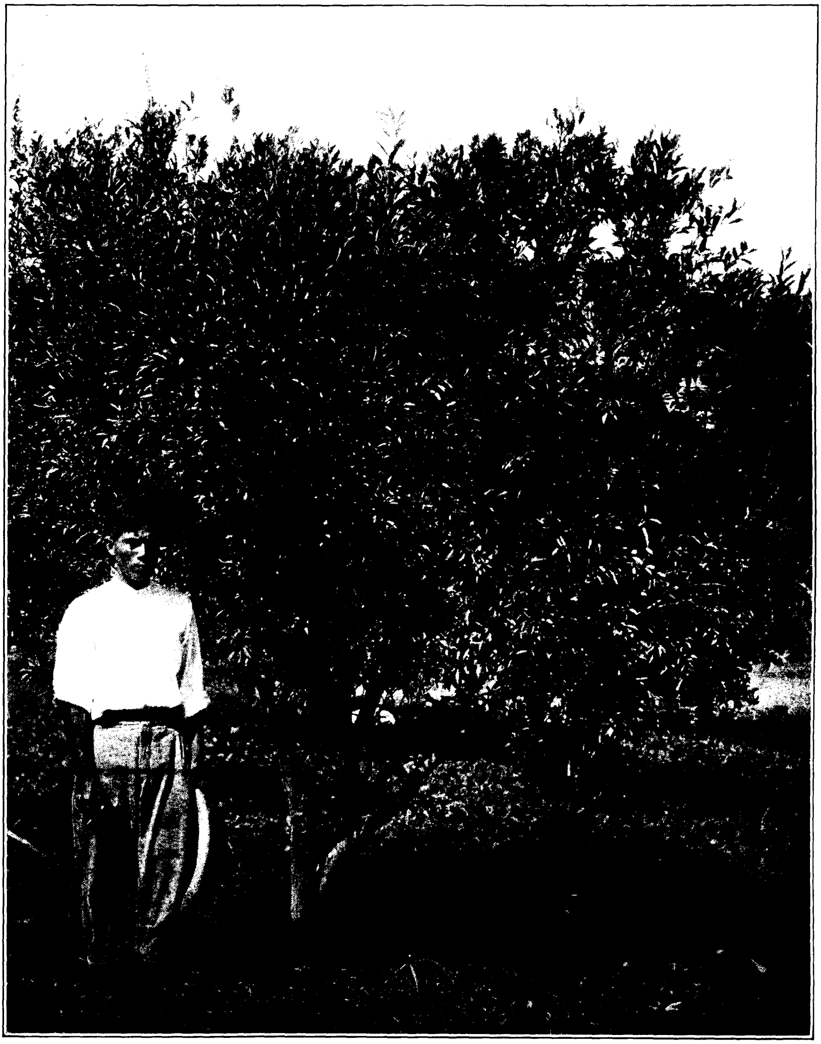
The susceptibility of *Chaetospermum glutinosa* (*Aegle glutinosa*) listed by Wester in his publications will be treated in a subsequent paper dealing with the canker susceptibility of genera related to *Citrus.*

Citrus hystrix, typical specimen, Lamao Experiment Station, Lamao, Bataan.

Mandarin *Citrus nobilis* in full bearing, Santo Tomas, Batangas.

Citrus Nobilis (Tungerine) recovering from gummosis on multiple stem type.

Mandarin Grove affected with bark rot, Santo Tomas, Batangas.



Szinkom, Citrus Nobilis, Lamao Experiment Station, Lamao, Bataan.

Trunk of Mandarin tree affected with bark rot, Santo Tomas, Batangas, P. I.

The flakes of dried bark having been brushed off exposing the sores made by bark rot, Santo Tomas, Batangas, P. I.

FRUIT TREES AND TREE PLANTING.

By P. J. WESTER, *Agricultural Advisor, Department of Mindanao and Sulu.*

Fruit trees are inextricably connected with the folklore and history of the human race since the dawn of civilization. According to biblical history the occupation selected by the Creator for the first man was fruit growing, and the eating of a fruit was the immediate agency of the fall of man, and the first step in the slow advance of the civilization of which we are the heirs. Grapes were grown already by Noah, and the pomegranate was cultivated by the Israelites for use in their religious rites.

In Scandinavian mythology the apples of Iduna conferred perpetual youth upon those who ate them, and the mango, believed to have been in cultivation for 4,000 years, is still considered a sacred tree by the Hindus. The olive was cultivated by the ancient Egyptians, and the fig was known to several of the ancient peoples in the eastern Mediterranean countries. The banana was cultivated since time immemorial in tropical Asia and Polynesia.

However, while legend and history both are full of interesting references to fruits and fruit trees, their systematic culture was one of the latest developments in the evolution of agriculture, being long preceded by animal husbandry and the cultivation of cereals. In fact the expansion of fruit growing and its elevation on par with other phases of agriculture did not take place until during the latter half of the past century. In the tropics we are just beginning to realize the importance of the fruits and to take the initial steps for their improvement.

Fruit trees are of course grown primarily for their fruits but many kinds are also so well adapted for these purposes that they may well be planted to serve as shade or ornamental trees also and thus fulfil a dual purpose.

Few trees surpass in majestic beauty a well grown mango tree. As a symbol of strength and majesty combined with airy gracefulness how many trees equal or even approach the

tamarind, the name itself of which is suggestive of the tree. The somber stateliness of the pili and the kanari is not appreciated in accordance with their merits or we would see these trees planted more frequently for shade or as ornamentals for which purposes the first mentioned especially is now all but never used.

In the moist regions of the Philippines, for instance Mindanao, Basilan, Jolo, the Bicol provinces, and Laguna, the bauno and marang would make attractive and suitable shade trees. An avenue of baunos with their straight, manssive trunks, their dense, symmetrical crowns would always command attention. In bloom, with tops one solid mass of lilac they would be a most impressive sight worth travelling a long distance. The marang, with its enormous, dark green leaves funishes another type of a decorative shade tree that would find many admirers.

As a rule fruits please the palate rather than furnish nourishment, though many are rich in starch and sugar and a few even in fat and protein, but the fruits are valuable nevertheless in stimulating digestion and in introducing change and variation in the diet. When it is also remembered that once established, fruit trees in the Tropics continue to yield abundant crops one year after another with less care and attention than would any other crop, that they are more independent of rainfall than annual crops, such as rice, corn and vegetables, and that they are immune to locusts, the advantages of possessing a fruit orchard for home consumption are so great and obvious as to require no further argument.

In entering upon fruit growing as a business enterprise certain factors must be recognized in order to avoid failure or financial loss. When we consider the great number of species of fruit trees that may be grown in the Philippines, the diversified climate, and the many elements that combine to make a good location for fruit growing it becomes apparent that any advise offered in a short paper must be general in character, still, there are certain fundamental rules that apply in common to fruit growing and fruit trees that are worthy of observance.

The supply and demand for the fruit the production of which is contemplated should be carefully investigated. If the market in a certain locality is over-supplied with mangos and the price received for the fruit is low, it is obvious that it would be inadvisable to engage in the culture of this fruit notwithstanding that the district was well adapted to mangos. Transportation facilities from the point of production to the market should

next receive consideration; a locality might produce an unusually good orange, but orange growing there would be profitless if there were no means of marketing the fruit or if the cost of transportation to the market is excessive. Again, the climatic requirements of the trees must be recognized.

In a broad sense fruit trees in the tropics may be divided into three groups: (1) Those that succeed where the dry and the wet seasons are distinct and pronounced, such as the mango, tamarind, santol, duhat, guanabano and related fruit trees; (2) those that require a moist climate, with fairly abundant rainfall evenly distributed throughout the year and no long dry periods, or such trees as the mangosteen, marang, durian and the bauno; and finally (3) those fruit trees which are subtropical rather than tropical, which do not thrive in the hot lowlands but require an elevation of 600 meters or more to succeed well, such as the cherimoya, kaki and the mulberry; at a sufficiently high altitude even certain of the temperate fruits can be grown in the tropics, for instance the chestnut and the peach.

While the fruit trees may be planted on other lands, other conditions being equal the largest crops and the best flavored fruit is produced on rather poor to moderately rich, light and well-drained soils. Rich soils encourage a luxuriant growth of leaves at the expense of the production of fruit. The trees may thrive on wet, cold lands but the fruit produced is not so sweet and well flavored as that grown on the land recommended.

In the typhoon belt the susceptibility of a tree to injury from the wind should be taken into consideration, and trees with brittle wood should be planted where they are well sheltered naturally or else windbreaks planted.

Abundant sunlight and air are indispensable for the best results, both in regard to yield in quantity and quality. Neither are many flowers nor fruits produced on trees that are crowded, nor is the fruit borne under such conditions so sweet and well flavored as that on trees well exposed to light and sun. Then again, trees that are too closely planted grow tall and spindling in their efforts to get to the light, the fruit is in consequence more difficult to gather than on smaller trees, the lower branches become weakened and become a breeding ground for diseases and insect pests, which again spread more easily from tree to tree and are more difficult to control or eradicate where the tops of the trees come in contact. It is evident, then, that the proper spacing of the trees at the time of planting is a matter of great importance.

The trees should never be planted so close that the tops grow together when the trees shall have attained their full size. They should be spaced sufficiently far apart so that when they have reached their full growth the tops are from 1 to 2 meters apart

In order to facilitate the subsequent work in the orchard and for the sake of appearance the trees should be planted at equal distances and in straight rows.

When we stop to think that the planting of a fruit tree is an operation performed once in the life time of a tree that may extend from twenty to exceeding one hundred years it becomes apparent how important it is that the tree is properly planted and that it would be inexcusable to perform this work in a careless and perfunctory manner. In other words, the extra time and care expended in properly transplanting the young tree is well spent. It is the best of economy, for the more carefully a tree is transplanted the more rapidly does it recuperate, becomes capable of taking care of itself, and comes into fruiting.

The two cardinal points in successful transplanting of a tree are the digging of holes so large that roots can spread in a natural manner without being bent or forced in the course of planting, and not to allow the plants to dry out. In order the better to accomplish this latter aim about one-third of the top and most of the leaves should be removed from the plant just before it is being dug, the plants should be transplanted with a ball of soil around the roots if possible, and the work should preferably be performed at the advent of or during the early part of the rainy season. The trees should not be set out deeper in the field than they grew in the nursery, and the soil should be carefully worked in among the roots leaving no air-spaces. If the planting is done during the dry period a large basin should be made around the plant a liberal amount of water should be applied, and the trees heavily mulched. Thereafter water should be applied to the trees from time to time until they are well established.

In the Temperate Zone fruit trees are cultivated according to their need like any other crop and there can be no doubt but that the fruits in the Philippines would be no more plentiful and of better quality if the trees were cultivated here also.

In a young orchard annual crops may be grown between the trees and the cost of bringing these into bearing in this way greatly reduced.

Dead and dying branches, those severely injured by insects,

and branches that interlock so as to injure each other should be pruned away and the young growths cut back so as to make a well balanced tree. Aimless pruning without a definite object, the beneficial result of which is not known, should never be performed.

Immature and partly grown fruit is neither so well flavored, wholesome nor nutritious as fruit allowed to remain on the trees until nearly mature. The full development of flavor and aroma and the proper conversion of starch to sugar never takes place in fruit picked prematurely. Therefore, do not harvest the fruit until it is fully developed and nearly mature.

In closing let us remember that the tropics are preëminently the home of fruits and fruit trees and that the diversified climate of the Philippines makes possible the cultivation of an unusually large number of different kinds of fruits. A judicious selection of fruit trees planted on 1 hectare would provide a family with fresh fruit in abundance in every month of the year and still leave a handsome surplus for sale, a fortunate circumstance that it is hoped will be utilized to full advantage in an increase of fruit production by our agriculturists both to their own enrichment and for the benefit of the urban population.

ERRATUM.

On page 205 of this Review, Vol. X, No. 3, 1917, line 28, the sixth word should read $375.00.

THE PHILIPPINE

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EDITORIAL

The production of sugar forms one of the most important industries of the world, for the world's desire for it has been steadily increasing since it was first tasted. Wherever new countries, continents and islands have been discovered, there sugar cane has been one of the first plants to be carried and today the amount needed to satisfy the world's demand is measured in millions of tons. In its early days this substance was considered as a luxury and prized more on account of its pleasant flavor than its food value, but as time went on and the production increased gradually sugar came into more general use as a foodstuff. Yet with the years of use this product had received, it took the late war to bring home to the people at large its true value as a food. That likewise taught the scientist how much sugar could be depended upon as a source of synthetical compounds in the chemist's laboratory; as a preservative, a base, and a necessary constituent of medicine in the pharmacist's laboratory; and as a necessary substance required in modern day arts and trades.

However, greatly as the demand for this product increased each year, it was met with an equal production until the beginning of the war; but as a result of the new uses discovered for sugar and a fuller understanding of its true food value from now on the demand for sugar is bound to increase still more rapidly and unless something is done to stimulate the production of this necessary foodstuff the supply will fall extremely short of meeting the demand for many years to come. It is imperative, then, that every effort be put forth in the shortest possible time to bring into bearing new lands that are now idle, and to increase to the fullest the production on those lands which are yielding only a small portion of what they are capable.

In the Philippine Islands not only does the sugar cane find its home but also various other sacchariferous palms such as the sugar palm (*Arenga saccharifera*), burí palm (*Corypha elata*), nipa palm (*Nipa fructicans*) and others.

The sugar industry of the Philippine Islands dates back for hundreds of years. In fact sugar cane was one of the first cultivated plants observed growing here when the Islands were discovered. The industry gradually increased in importance but the old and antiquated systems were continued in the field and at the factory, except to a small extent, until America came into possession of the Islands, when modern factories were introduced, manufacturing the highest grade of centrifugal sugar, was made which meets the present day market demands and brings the highest price for sugar of its kind.

It is estimated that there are enough suitable lands in the Philippine Islands to produce a million tons of cane sugar when the industry is well developed, in addition to that which the great areas of nipa and other sugar-producing palms are capable of producing.

The scientific systems employed now-a-days of caring for soils and conserving their fertility for the future as well as producing large crops for the present will insure large future yields instead of permitting a decrease from year to year as was experienced by the old *soil breeding* system of the past.

The tissues of the sugar cane plant form only a home for sugar, a factory, as it were, wherein the carbon, hydrogen and oxygen derived from the air and water may be manufactured or synthesized into the new compound, sucrose, and stored until required to feed the plant in its declining years or to serve man as food.

The rest of the plant may well be returned to the soil, so far as supplying man's needs are concerned, for not an atom of the inorganic plant food elements enter into the sugar demanded as a human food. In former times and in fact until recent years it was the custom of the old planters never to return any of the by-products of sugar manufacture to the fields, and even the ashes from the bagasse were used on the roads or thrown into rivers in order that they might not "contaminate" the soil, for it was feared they would either make the cane grow so rank as to break the little mills during its grinding or to yield juices of such low purities that good grades of the open kettle muscovado sugar could not be made from them. Some of those lands are almost devoid of organic matter, as it was the custom of planters to burn off all plant material after the crop was harvested in order to facilitate cultivation and prevent the land from becoming "too rich." As a result of such ill treatment those lands are now in a poor state of fertility and require special attention of the modern agriculturist to bring them into bearing again.

Experiments conducted by Mr. C. W. Hines, Sugar Technologist, Bureau of Agriculture, on various plantations and demonstration and experimental stations have proved that a rational system of treating the so-called *depleted* but better turned *mistreated* soils, to which some of the booty consisting of necessary plant food elements of which they have been robbed, are properly returned, and organic matter is incorporated in the soils, is very profitable, netting most satisfactory returns in the way of larger crops from the very first year following the inauguration of the new system.

Yellow Caledonia sugar cane growing at Alabang Stock Farm

ESSENTIALS IN THE PRODUCTION OF SUGAR CANE

By C. W. HINES, *Sugar Technologist*

THE SOIL

The term soil refers to the very complex structure composing the surface of the earth. Soils vary greatly in depth as well as in composition on the various plantations. It is difficult if not impossible to find identical soil specimens in the different parts of the same plantation, however closely they may resemble each other in their external appearance. A knowledge of the evolution and a complete history of the various soils on the plantation supplies the up-to-date sugar planter with information that is not only interesting but also important since it leads to the proper handling of each particular type of soil in order to produce maximum crops.

The formation of soils from the decomposition of rocks and organic matter is not a task that was completed in times gone by. The agencies which brought about these conditions from the time the earth's surface consisted of rock formations are bringing about similar changes today. These changes go on at a more rapid rate however when the intelligence of man is employed in devising methods of handling soils which cause more rapid disintegration and the consequent decomposition of the rock particles into a form available for plant nutrition. It may be said that no soils are "made" but that they are all in the making, and the rapidity with which this transformation takes place on cultivated fields depends largely upon the treatment they receive.

Soils consist of a mixture of the rocks and rock particles constituting the greater portion of the mineral matter and the remains of plant and animal tissues that make up the organic matter. In addition there are always present various gases and water.

The rock particles are for the most part inert material as far as their direct aid to plants in providing them with plant food material is concerned. These particles, however, perform a very important function in maintaining a suitable dwelling place for the root system of the cane, as will be observed later.

Soils are roughly divided into surface soils and sub-soils. The former make up the upper stratum, which contains more or less organic matter. The limit of the surface soil may usually be determined by the darker color and difference in the appearance of the formation. Even in the surface soil the rock particles are never entirely decomposed; for in such a condition the plant food material would be leached away and lost before it could be used by plants, while, at the same time, the physical or mechanical condition would be greatly impaired.

The shallow stratum of earth lying immediately beneath the soil is designated as the subsoil. This contains but a limited amount of organic matter, derived mainly from the roots of plants and from the excrement and bodies of burrowing insects. The rock particles in the subsoil do not present the advanced stage of decomposition found in the upper stratum or surface-soils, due to the fact that they are acted upon to a lesser degree by the air, sunlight and water. Below this stratum still less decomposition takes place and the soil here quite often presents the form of the original rock. As the upper surface is cultivated, year after year, and heavy crops are removed with each harvest, the surface gradually wears away until, if deeper plowing were not resorted to yearly or, rather, if a small amount of this crude material from the sub-soil were not yearly mixed in, the cultivated area would in time become very shallow. It is therefore customary to plow just a little deeper each year than the previous year and gradually break up this lower stratum so that it will be reduced to fertile soil. In this connection it may be remarked that the implement known as a subsoiler serves an important purpose on sugar plantations, since it causes the lower stratum to be broken up without the addition of such a large amount of this crude material to the surface soil as would result from the use of an ordinary plow. This material would impair the fertility of the soil until the soil-forming agencies could convert it into a suitable form. This subject will be discussed further along, with soil preparation and cultivation.

There are three classes of soils with which the various sugar planters of this age have to deal; namely, virgin soils; those which have produced crops year after year and, through proper treatment, have been maintained in fertility; and the so-called "worn out" soils, or those which have been improperly handled.

In early days, when there was an abundance of virgin land available, it was considered an easy task to clear this land and plant whatever crop was desired, year after year, until the land was in such an unsuitable condition for the growth of cul-

tural plants that it no longer produced satisfactory crops. The planter was then ready to move on and select another suitable tract of land, there to repeat his same methods. The demand for farm products was not so pressing, too, which was another reason why such methods could very well be tolerated. With the increasing population and the establishment of better standards of living throughout the world, economic conditions will not permit such waste to take place. The farmer nowadays has either to suffer the results of such ill-treatment given the soil or devise means whereby the harvesting of large crops may go on indefinitely. Such conditions are coming about in the production of sugar, as the full importance of this product both as food and in the arts is properly realized. This will eventually result in the survival of the fittest among sugar planters, and those who are not able to do their all in the world's great economic problem will be relegated to other tasks and replaced by the efficient.

When it is considered that various soils in China have been cultivated constantly for thousands of years and produce larger crops today than they did when first cultivated, it must be admitted that the treatment those soils received had much to do with increasing or even maintaining their fertility. If such results are attained only by studying nature's way in a rudimentary fashion it is easy to see what can be expected when planters realize the value of a constant application of the science of agriculture in the production of crops.

The practice so extensively followed on many sugar plantations of letting the land lie fallow, after the production of a number of crops of cane, if the yield begins to decrease, no doubt has some virtue in it, provided that conditions are favorable for the operations of the nitrifying bacteria; but it is not absolutely necessary that it should be resorted to when modern ingenuity would have the land producing a remunerative crop while at the same time increasing in fertility. The practise of rotating crops, the more especially when one of them is a legume, not only tends to permit the toxins from the previous crop to be oxidized and destroyed but also permits the storing up of nitrogen; and if the crop is turned under or used for pasture a valuable supply of organic matter is added as well. In the light of modern investigations into soil fertility it is evident that something more than a favorable physical composition and a fair content of the necessary plant food elements are required to make a soil productive. It has been demonstrated that many of the so-called worn-out or exhausted lands

are in reality better prepared to produce large crops, so far as their physical condition and the supply of available plant-food material are concerned, than some of the soils classed as being fertile. Many sugar planters believe that there must be present in the soil a very large supply of the necessary plant-food elements and that a chemical analysis of their soil is the only guide that will be required to lead them to the road of success in the production of sugar. This is an erroneous idea, as planters have often learned to their sorrow. It will not be disputed that a soil analysis is a valuable guide to the agricultural expert to aid him in determining the treatment to be given the soil, but it is a dangerous guide in the hands of the ordinary planter when he relies entirely upon its results for his store of information on the soil, as is quite often the case. Even if the analysis showed the exact amount of the various elements in a form available to the plants, it would yet fall short of giving the necessary information leading to the production of large crops, though it would be a valuable guide in this respect.

Roughly speaking, each ton of sugar removes from the soil 1.5 kilograms of potash, 1 kilogram of phosphoric acid, 0.8 kilogram of nitrogen and 1 kilogram of lime. Where proper cultural conditions are obtained, the root systems of the various rows will overlap and consequently the entire area of the field will be drawn upon to supply the plant with these elements. Assuming that the ordinary depth to which the soil is plowed will be 20 centimeters and that the root system of the cane will not extend beyond that depth in search of food (which is not in reality a fair assumption), a hectare of land the chemical analysis of which indicates the presence of 0.40 per cent potash, 0.12 per cent phosphoric acid and 0.80 per cent lime and 0.18 per cent nitrogen, will contain approximately 10,627 kilos of potash, 3,188 kilos of phosphoric acid, 4,783 kilos of nitrogen and 21,255 kilos of lime.

There would be present in this shallow depth of soil only enough nitrogen to produce 5,980 tons of cane, enough potash to produce 7,085 tons and enough phosphoric acid to produce 3,188. The above calculations are based upon the total exhaustion of the soil included in the shallow stratum of 20 centimeters and do not allow for the plant-food material, removed from beyond that depth—that which would be returned with the ash from the bagasse and other sugar-house refuse—and the nitrogen from the air deposited in the soil by legumes, when a proper system of crop rotation is practiced for maintaining

soil fertility. However, while the above figures are interesting as indicating the possible limitations of the plant-food material which is returned, yet in the light of scientific agricultural methods they do not indicate much to the up-to-date sugar planter.

High-grade sugar consists of almost pure sucrose, which is a carbohydrate with the chemical formula C_{12} H_{22} O_{11}, or carbon twelve parts, hydrogen twenty-two parts and oxygen eleven parts. The entire mineral constituents of the plant, together with the nitrogen, are discarded in the production of high-grade sugar, so these are found only in the by-products of manufacture. Where the by-products are applied in the soil, practically the entire amount of plant food elements removed with the previous crop are returned to the soil. Fortunately the majority of them are in a form directly available to the plants. During the combustion of the bagasse at the factory, the nitrogen escapes and is lost; but a new supply is readily obtained by growing legumes. Thus by a system of plant rotation the supply of this element instead of being depleted may be increased.

The presence of soil toxins or plant poisons exerts a remarkably detrimental effect upon growth. All plants give off material which is more or less toxic to that particular plant and to many other classes of plants as well. A noteworthy example of this nature may be found in the various sugar districts of the Philippines, where the large reed-like plants *Saccharum spontaneum* (known as "tigbaw" and thought to be a remote ancestor of the sugar cane), grows in abundance on the uncultivated lands. It is utterly impossible to grow a good crop of sugar cane on such lands unless they have been given special treatment previously. This usually consists of plowing the land and thoroughly incorporating in the soil a large supply of lime either in the carbonate, oxide, or hydroxide form and in keeping the soil well aerated by plowing and disking from time to time. This treatment entails the loss of the land for at least a year and even then the first few harvests of sugar are not so good as the succeeding ones unless corn or some other crop is previously planted.

PHYSICAL CONDITION

The various chemical elements of soils are present in the form of both mineral and organic compounds. The proportion of each of these two constituents present as well as the condition in which they exist, exert as great an influence upon the productivity of a soil as do the chemical compounds themselves.

Sugar cane does best on soils not only properly supplied with the necessary plant-food elements but also where suitable physical or mechanical conditions exist. Under such conditions the roots are able to reach out a very great distance to secure plant food and at the same time the soil waters are better able to bear dissolved plant-food material to the rootlets as well as to transfer appropriate chemical compounds which serve to neutralize detrimental plant toxins. It is the favorable physical conditions within the soil that are largely responsible for the heavy yields of cane on well cultivated plantations.

Unlike many other plants of the graminaceae, the sugar cane sends up numerous stalks, due to the development of its rhizomes or underground stems in the root system. Where these rhizomes are improperly fed or where unfavorable growing conditions exist, the number of stalks that are produced to each stool of cane is curtailed and a smaller growth also results. In the production of a successful crop of sugar cane there should be not less than 100,000 stalks per hectare. If suitable conditions be obtained within the soil for the growth of the cane so that it may properly develop, each stalk should weigh not less than one kilo.

The average number of stalks produced per hectare on various plantations of the Philippines which are in poor physical conditions ranges between 40,000 and 60,000 instead of 100,000 stalks as on well cultivated plantations. The production of such a small number of stalks is due largely to the fact that the eyes or buds of the rhizomes are so securely inclosed by the soil particles which are tightly cemented around them that it is impossible for the buds to develop.

It is no doubt true that if all of the buds of the rhizomes developed the stalks would be so crowded together that they could not grow properly, but this condition has never caused planters any great alarm, for nature has made a very wise provision against such a happening. It is, therefore, no excuse for the planter to neglect the physical condition of his soil.

TEXTURE

The texture of a soil refers to the size and the proportion of each class of soil particles present. This factor governs largely subdrainage as well as the moisture retaining capacity of soils. The texture of a soil is determined in the mechanical analysis by passing the specimen over screens of certain specified

meshes. The various types are roughly classed according to the United States Bureau of Soils as follows:

	Millimeters.
Clay	0.005
Silt	0.050-0.005
Very fine sand	0.100-0.050
Fine sand	0.250-0.100
Medium sand	0.600-0.250
Coarse sand	1.000-0.500
Fine gravel	2.000-1.000

Particles larger than 2 millimeters in size are classed as gravel and stone.

Soils never contain particles all of the same size, but on the contrary they are composed of a mixture of all of the above-named particles together with organic matter, and the proportion of the various constituents present determines the class of soil that is formed. A clay soil is not one where all the particles are less than 0.005 millimeter in size, but one in which there is a preponderance of the above class of particles although there may be present any or all of the other constituents.

A soil which is composed of large particles is said to have a coarse texture. Such a soil is of poor moisture-holding quality; it also permits the plant-food elements present in a soluble form to leach away and thus it is very likely to be somewhat deficient in available plant-food material. This results since gravity water readily passes among the soil particles and drains away, carrying along dissolved plant-food material. Such soils do not convey suitable quantities of capillary water to the surface and in addition they hold but a limited amount of hydroscopic moisture, as their total surface area is small. On the other hand a coarse textured soil offers better opportunities for aëration or soil ventilation, whereby a supply of air is retained in the pores for the oxidation of the soil particles and the plant toxins, as well as to supply oxigen to the roots of the plants.

Conversely, the soils with a fine texture, like many of those found in the Isabela district, offer resistance to drainage and aëration; but at the same time they do not permit the water to drain away so readily as to carry an abnormal amount of soluble plant-food material with it; consequently such soils are usually rich in soluble plant-food material.

Each of the two classes of soils, with reference to its physical conditions, has certain points in its favor as well as certain other distinctly unfavorable qualities. It will be observed from the mechanical analysis of productive cane soils of the

world that a medium between the two extremes, other conditions being equal, gives the best results.

The gardener often finds it advantageous to alter the texture of his soil by making it lighter or heavier, as the case may be. This he accomplishes by applying certain material to give the desired mechanical texture. Obviously this could not be done on sugar plantations where there are hundreds or even thousands of hectares under cultivation; so other means must be devised for handling the situation. It has been the writer's experience that distinct methods of handling each particular class of soil must be employed if maximum results are to be obtained. Some soils are greatly improved both chemically and mechanically by applications of lime, while others might possibly be harmed by such treatment. Applications of organic material will undoubtedly improve the majority of soils, while they would not improve and might even be detrimental to certain classes of peaty and muck soils.

Some soils will puddle badly when plowed wet, and bake or become very hard after drying. They are in poor physical condition for some time after being plowed because the particles have become cemented together forming large and firm lumps. Other soils lose their moisture readily unless a mulch of fine earth is maintained over the surface. The former should be handled when there is not an excess of moisture present, while the latter should be prepared while there is yet an abundance of moisture; and in the latter case every possible advantage should be taken to mulch the surface and thus to guard against the escape of the moisture which will be of material importance during periods of drought. The various parts of the plantation contain soils differing materially from each other and it is the duty of the planter to apply methods best suited for the handling of each particular class. This he can do without any great difficulty and thus offset their unfavorable texture.

INORGANIC MATTER

The greater percentage of the substances from which soils are formed consists of mineral matter. This is derived entirely from the rocks and may consist either of the original rock particles or their remains after decomposition has taken place. The character of the rock formation from which the soil particles were derived determines, to a very great extent, the class of soil that is formed; the degree to which these particles are decomposed largely determines the fertility of the soil. The rocks found in the immediate vicinity are not always responsible, however, for the character of the soil that

is formed, since these rock particles are quite often brought from great distances by such agencies as the wind, water, and volcanoes. The transported soils thus produced are found on many plantations in the various sugar districts of the Archipelago.

It is quite often observed that the rich alluvial soils like those of the Isabela district of Occidental Negros largely result from the transporting to the valleys of great supplies of humus-forming material from the higher surrounding country. The average constituents of plant food material in the soils of this particular valley show it to contain approximately 1.46 per cent of nitrogen, 1.86 per cent of phosphoric acid, 0.13 per cent of potassium and 1.50 per cent of lime. The rich soils at the foot of Mount Canlaon in Occidental Negros, Mount Isarog in Ambos Camarines and Mount Mayon of Albay were the result of deposits of volcanoes. These regions have always been particularly rich in potash, and the volcano deposits have provided material for such a favorable mechanical condition in the soils that a dense growth of vegetation has grown up, the decay of which has caused a large supply of humus to be formed.

The original rocks from which the soil was derived are broken down by such agencies as the flow of water, changes in temperature, wind, volcanoes, plants and animals; and the particles formed thereby are readily acted upon by the various chemical elements and compounds, thus causing the plant-food material therein contained to be changed into a form available to plants. While these chemical changes would take place to some extent even though the rocks were not broken into small particles, yet the change would go on more slowly, because a smaller surface area would be available for the chemical action.

The corroding or rusting of iron, the softening of brick and stone used as building material and the crumbling of rock surfaces are all familiar examples of this chemical change. The air, which is composed of various gases, assisted by water and sunlight, performs an important function in the decomposition of soils; and this is one of the points favoring cultural methods which keep the soil in a well aërated condition. Another thing of importance in bringing about this change is the soil water, which is quite often laden with the weaker acids such as humic acids. These tend to decompose the various rocks, forming new compounds which are usually soft and readily dissolved. A third factor of importance is the presence in the soil or carried about by the soil water of sodium chloride (common salt), calcium sulphate (gypsum) and numerous other chemical compounds.

When these substances come in contact with certain classes of rock particles, there results an interchanging of the elements with the liberation of soluble plant-food material. The increased crop yields resulting from applications of such material have given rise to the mistaken belief among planters that they constitute fertilizing material.

Several planters have applied gypsum, or land plaster, indiscriminately to their soils with the result that the crop yields were materially increased the first year or two but the later yields were smaller than those experienced before its application.

While it is highly desirable to have a sufficient supply of available plant-food material present in the soil for the immediate needs of the crop, there is danger of an unnecessary loss through leaching if too much of this material is liberated at a time. For this reason it is important that such chemical compound be applied to soils with extreme care, if indeed they are applied at all. It should be borne in mind that only the required amount of any such chemical to liberate a limited supply of the plant food should be employed at one time.

There are soils which analyses show to contain an abundance of the necessary plant-food elements but in practice they fail to produce well. In many such cases it has been found that one or more of the necessary plant-food elements is unavailable or locked up, so to speak, and hence it was of no service to the plants. It is highly desirable that suitable conditions in the soil be maintained, which will cause the rock particles to be decomposed and permit this plant-food material to be gradually liberated for the use of plants. To accomplish this, the farmer should see that his land is kept in a well aërated condition. He should make liberal applications of lime, especially if the soil is acid, lacking in this element, or heavy. The lime in some cases may interchange its calcium for plant-food elements contained in the rocks and thus cause their liberation in a soluble form for the use of plants. He should have a large supply of organic matter well incorporated in the soil. Should these as well as other methods which will be mentioned later fail in bringing about the desired result, application may be made consisting of the proper amount of appropriate chemical compounds to assist in decomposing the rocks and liberating the plant-food elements.

Among the various elements required in building up the tissues of plants may be mentioned phosphorus, potassium, nitrogen, calcium, oxygen, hydrogen, carbon, sulphur, silicon, magnesium, sodium, chlorine and iron.

The majority of these elements are present in abundance in all soils. The first four elements are sometimes referred to as the necessary plant-food elements, since these are present in relatively large quantities in plants. As they are quite readily lost from the soils by leaching and other means, they are sometimes applied to the soil in the form of fertilizers.

The oxygen, hydrogen and carbon are present in great abundance in the air and soil water, while nitrogen is present in unlimited quantities in the air. Nitrogen is unavailable, however, to such plants as sugar cane, while in the pure state, as in the air; this element must first be deposited in the soil by one of the leguminous plants now used extensively on the plantations conducted along modern lines, or by means of bacteria which thrive without a host plant.

In case of sugar cane the principal elements contained are derived mainly from the air and water. Only about one-half of one per cent consists of mineral matter but without this constituent it would be utterly impossible to produce a crop of cane.

It is evident that nature has made a very wise provision for the feeding of plants and has endowed them with power to obtain the necessary plant food even when there is but an infinitesimal amount of each particular element present. It is absolutely essential, however, that these elements exist in a form available for their assimilation. A noteworthy example of this nature is found in the seaweed (kelp or mammaria) which extracts great quantities of iodine from the water of the ocean, though delicate chemical tests reveal the presence of but a negligible quantity in the sea water.

In parts of the Philippines there are rich lands that are covered with tigbaw and cogon. These soils fail to produce large crops mainly because of improper assimilation of the plant food contained, by the cane, due to the effect of toxic material. Such soils require proper treatment to neutralize the toxins from the previous growth and restore suitable conditions for the development of cane rather than the application of available plant-food elements.

The same plant-food element may be applied in different forms of fertilizers to cane on uniform land and invariably there will result a difference in the yield from each of the different fertilizers, although they were all applied in the same quantities and all were in an available form. This leads one to inquire if it is not possible that certain of the substances or possibly a very small amount of some unsuspected foreign substance contained

therein did not serve some other purpose than that of merely feeding the plant.

The human system often responds to the effect of very small quantities of certain chemical compounds. These supply the body with neither weight, heat, nor energy; hence they are not foods, yet they in some way spur the body on the greater action and for that reason are termed stimulants. It is possible, indeed quite probable, that there are elements and compounds which act as plant stimulants. For instance, it has been observed that when there is but a very minute quantity of certain soluble compounds of iodine applied to growing cane, in some way or other the maturity of that cane is materially hastened, while at the same time a marked improvement is made in the sucrose content and purity coefficient of the juice.

It is evident that the successful sugar planter who expects to maintain the fertility of his particular soil must be willing to devote endless study and research to his special plantation problems in order to discover nature's secrets in the proper handling of the soil. He should take nothing for granted nor assume that the methods followed by his successful neighbor will answer as well for his plantation. Indeed it has been shown that he will find it necessary to employ different methods even on the various parts of his own plantation unless the soil is extremely uniform.

POTASSIUM

This element, like practically all of the other elements used to any extent in the building of the tissues of sugar cane, does not appear in nature in the uncombined state but instead it is always found in compounds containing other elements.

Potash is the term commonly used to designate the chemical compound containing this element when reference is made to its presence in soils and fertilizers. This substance consists of a combination of two parts potassium and one part oxygen. Potash is one of the most soluble forms in which the element exists and it may be assimilated very readily by the cane.

Potassium is usually present in abundance in ordinary cane soils of the Philippines and only in exceptional cases has it been found necessary to make special applications in the forms of fertilizers. In numerous cases applications of soluble forms of potassium have given excellent results notwithstanding the high potassium content of the soils as shown by a chemical analysis; but this was due to the fact that the potassium present was not in a form available to the cane. In such cases as the above, it is important that cultural conditions be maintained

which will favor the disintegration and decomposition of the soil particles containing this element. Applications of lime in many cases have been advantageous in causing an interchange of the plant-food elements contained in soil particles with the consequent liberation of potassium in a soluble form. Similar results may be obtained by applying various other chemical compounds to such soils but lime is the safest material to apply.

Due to the fact that much of the potassium in ordinary soil exists in an insoluble form, it is not readily lost in the drainage waters, and, for this reason, it is found by chemical analysis that the percentage of this element is quite large. Low, boggy lands containing much peaty materials are, however, often deficient in potash. This is due to the fact that the potash derived from organic compounds is usually in a soluble form and consequently readily leached away and lost with the drainage waters.

There have been various theories advanced as to just what function potassium performs in the growth of plants but none of them give a very satisfactory explanation. It has been observed that sugar cane when grown on lands containing but a limited supply of available potash invariably has a yellowish color and makes a very slow growth. The stalks are quite often shriveled up and poorly developed. This is no doubt because potassium in some manner performs an important office in the synthesis of starch, possibly in the transfer of this material or its incomplete forms from the leaves to the various parts of the plant. Moreover, when sugar cane is grown on soils containing but a limited supply of soluble potassium it becomes much more susceptible to various fungus and other diseases.

It has been stated that sugar cane contains approximately 1 per cent of potash. That portion which is present in the leaves and tops of the cane is returned immediately to the soil, after the crop is harvested, while only a limited amount of the remainder is lost from the soil if the ashes from the bagasse and the molasses or the lees from the molassses, in case this is converted into alcohol, are returned to the soil. If the by-products of sugar production are properly handled, the supply of potash from the previous crop is practically all in an available form for the immediate use of the succeeding one, only in the latter case a little more time is required to effect the decomposition of the compound and liberation of the potash.

It has been mentioned that certain lands are occasionally encountered which are deficient in potassium and for this reason applications of fertilizers containing this element in an avail-

able form will give good results. There are various forms in which this element is used in fertilizing material, among the more common being the chloride and sulphate.

In tropical countries like the Philippines, where there is a great deal of rainfall, the chloride often gives very good results, but in arid regions there is some danger of an accumulation of the chloride compounds, and an excess of this acts in a detrimental manner to many plants. But in tropical countries with the heavy rainfall which commonly occurs, it is possible to find soils quite deficient in chlorine. Since this is a necessary constituent of plants, being present to more or less extent in the leaves, it is therefore possible that under such conditions the chlorine of potassium chloride may act beneficially as well as the potassium.

PHOSPHORUS

Phosphorus, like many of the other elements found in soils, does not appear in nature in the uncombined state. It would not be desirable to apply this element to plants in such a condition even if it were possible, due to its extremely active qualities.

This element is present to some extent in all soils. It is also found in great deposits of rock-bearing phosphates, in the bones of all animals and in the mineral content of plants.

In the various rock formations it is usually present in the form of a calcium phosphate. The rock known as apatite, with the formula $3Ca_3\ P_2\ O_8\ CaCl_2$ or $3Ca_3\ P_2\ O_8\ CaF_2$, is particularly rich in phosphorus; and this forms a common source of supply of the phosphorus used in commercial fertilizers.

The phosphorus found in ordinary bones appears mainly in the tri-calcium state. This material is extensively used as a source of phosphorus in commercial fertilizers. The bones require treatment after being ground into small particles in order that the phosphorus may be reduced to a soluble form which is immediately available to such plants as sugar cane.

The widely different forms in which this element exists, each of which has a distinct solubility peculiar to itself, cause a great difference in its availability to plants. It has been previously remarked that in order for any element to be available to plants it must necessarily be in a soluble state. Some of the forms in which phosphorus is found are extremely soluble, hence they may be assimilated at once by sugar cane; but again they offer the disadvantage of being readily lost from the soil through leaching.

One of the most soluble form of all is that of phosphoric acid,

the formula of which is $H_3 PO_4$. The anhydrous form of this substance contains 43.7 per cent of phosphorus.

Among the various forms in which phosphorus combines with calcium may be mentioned the mono-calcium phosphate, $CaH_4 (PO_4) 2$, di-calcium phosphate, $Ca_2 H_2 (PO_4) 2$, tri-calcium phosphate, $C_3 (PO_4) 2$, and the tetra-calcium phosphate, $Ca_4P_2O_9$.

The first-mentioned form is available to sugar cane because it readily dissolves in ordinary soil water and may be absorbed by the rootlets of the plant. On account of this fact it is often termed water-soluble phosphoric acid when referred to in commercial fertilizers. It is also called mono-basic phosphate, acid-calcium phosphate, acid phosphate, of lime, acid phosphate, and soluble phosphate of lime. This form contains 60.7 per cent of the anhydrous phosphoric acid ($P_2 O_5$) or 26.5 per cent phosphorus. It is formed when calcium combines with the acid or where those forms containing more than one atom of calcium are treated with certain chemicals.

Di-calcium phosphate $Ca_2 H_2 (PO_4) 2$, sometimes called di-basic phosphate, citrate or acid soluble phosphate, reverted calcium phosphate, and secondary calcium phosphate, is soluble with difficulty in water and consequently this material is only available to a limited extent. This is a very safe manner in which to have phosphorus present in a soil, since it does not readily leach away and escape with the soil waters. At the same time it is available to a certain extent to sugar cane and through the agencies of acid waters in the soil and the oxygen from the air it is gradually changed into one of the more soluble forms. While it is advantageous to have the main store of phosphorus in the soil present in this form, there should be a limited supply present in one of the more soluble forms for the immediate use of the cane.

The tri-calcium phosphate ($Ca_3 (PO_4) 2$, sometimes called tri-basic phosphate, is insoluble in water and consequently it is of no practical value as a direct food for plants.

Like the di-calcium form of phosphorus and many other compounds containing plant-food elements, this substance slowly decomposes under soil conditions and the plant-food material is gradually liberated, although it requires a much longer time than is necessary for the di-calcium form.

Tetra-calcium phosphate, $Ca_4P_2O_9$, is sometimes known as tetra-basic calcium phosphate or tetra-basic phosphate of lime, also Thomas phosphate, Thomas slag, basic slag phosphate, or basic slag phosphate of lime. This material is extremely insoluble and is useful to plants only after it has been subjected

to special treatment. It contains approximately 39 per cent of anhydrous phosphoric acid or 17 per cent of phosphorus.

It will be seen that phosphorus is present in soils and various fertilizing compounds in widely different forms and many of these compounds possess entirely distinct characteristics. Where it is desired to purchase this element for application to soils deficient in available phosphorus, it is important to select a soluble form and apply only the required amount to obtain results in the most economical manner.

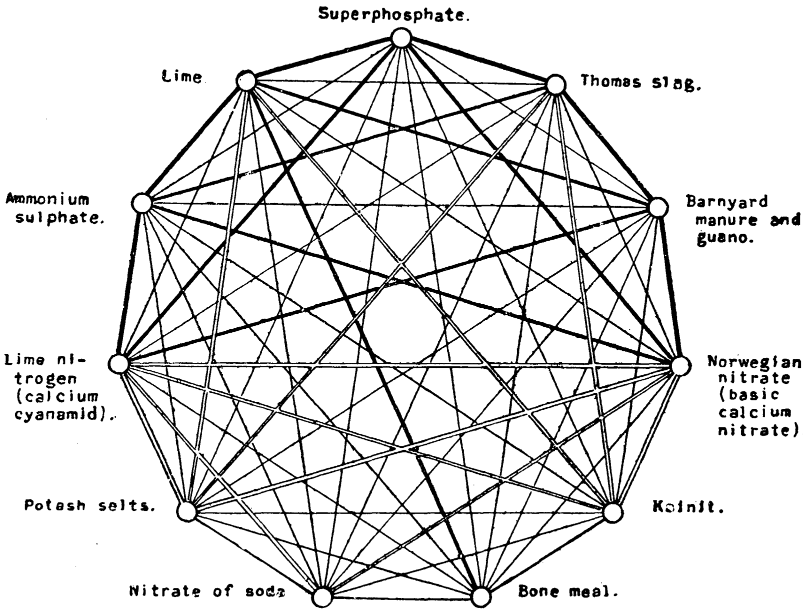
If a chemical analysis shows the soil to be well supplied with phosphorus and yet experimental plots on which soluble forms of phosphorus was applied show increased yields from the use of this fertilizer, it is evident that the phosphorus of this soil is present in an insoluble form. Cultural methods should in this case be employed that will cause the soil particles to be decomposed in order to liberate the phosphorus. This requires that the soil be well aërated in order that the oxygen from the air may assist in breaking down the chemical compounds. An abundant supply of organic matter should also be incorporated in the soil. This furnishes a medium in which soil bacteria may live and the acids given off during the decomposition of these organic compounds assist in the decomposition of inorganic soil particles.

It has been remarked that conditions may be maintained in the soil favoring the liberation of plant-food elements. Likewise under adverse conditions it is possible for the soluble forms of these elements to be changed to those which are insoluble and of little direct benefit to the plants. As an example of this class, may be mentioned where phosphorus is present in an available form and heavy applications of lime are given the soil. In such a case it is possible for the compound of phosphorus under certain conditions to combine with the lime and be changed into an insoluble form. This will explain why it is not safe to mix fertilizing material containing certain chemicals nor even to make extremely heavy applications of lime to certain soils where immediate results from all of the plant-food elements within that soil are desired. The familiar chart shown in Fig. 1 indicates graphically which fertilizing compounds may be mixed with safety and which ones should never be brought into close proximity.

Where proper conditions are maintained in the soil and the by-products from cane production and sugar manufacture are properly returned to it, there should be an abundant supply of phosphorus available for the cane at all times on those planta-

tions which were originally well supplied. There are exceptional cases, however, where the soil is composed mainly of materials deficient in phosphorus or in which the phosphorus was in a soluble form and has leached away.

Under such conditions the application of materials containing this element will give beneficial results. The explanation on the chemical compounds containing phosphorus should guide planters if they find it necessary to purchase this element in commercial fertilizers. Where such material is purchased, it



The heavy lines unite materials which should never be mixed. The double lines those which should be applied immediately after mixing. The single lines those which may be mixed at any time.

Fig. 1. Fertilizer chart

should be borne in mind that immediate results must be obtained and with that end in view the soluble forms only should be employed.

NITROGEN

This is one of the most abundant of all of the necessary plant-food elements. It composes approximately four-fifths of the atmosphere. Here it exists in the uncombined or free state and above each hectare of land there is estimated to be present nearly eighty-six thousand tons of pure nitrogen. In this con-

dition, however, it is of little practical value to sugar cane; but through the medium of bacteria which thrive in the root nodules of leguminous plants the nitrogen may be changed into various chemical compounds and deposited in the soil. In this manner it becomes available to nonleguminous plants such as sugar cane.

Nitrogen, like many other plant-food elements, is present in various compounds in the soil and in fertilizers. Not all of the nitrogen contained in this material, however, is available to sugar cane, and some of the forms even appear to be more or less toxic to that plant. It is important that an ample supply of nitrogen in the favorable forms be present in order to obtain best results in cane production. Such plants as the sugar cane can best use nitrogen in its nitrate form which readily dissolves in water and is directly available to the cane. It is thought that nitrogen in the form of ammonia is avialable to a limited extent to sugar cane but this is not considered as the most satisfactory form for use on sugar plantations.

Nitrite is quite different. This substance is entirely unsuited to the growth of such plants as sugar cane, since it acts as a plant toxin or poison. The useful forms of nitrogen may be changed into this form under certain adverse conditions and thus become detrimental rather than beneficial to sugar cane.

Nitrogen has often been classed as the limiting factor in soil productivity. Few plants can get along without this element and yet it is extremely fugitive when in a soluble form, so that it is readily lost from the soil. In the first place this material is easily dissolved in water and may escape from the soil through leaching. Again there are classes of bacteria which destroy nitrogen compounds and thus liberate that element. Nitrogen is usually the most expensive of all of the necessary plant-food elements when purchased as a fertilizer and yet it is the one most easily provided if proper crop rotation is practiced. The other plant food elements are derived entirely from the soil and it is never possible to increase the supply, however carefully the plantation work may be conducted without the application of material bearing these elements from other sources. The very best that any planter can do is to provide conditions in his soil favorable for the gradual liberation of these elements for the use of his crops. The case is quite different with nitrogen, as there is an unlimited supply of this element available in the air and, as has already been explained, the destruction of nitrogen-bearing compounds through denitrifying bacteria, decomposition through burning and other means, cause quantities of nitrogen to be again liberated and restored to the air, so that

the supply therein can never become materially reduced, much less exhausted.

In view of the unlimited supply of nitrogen at the command of the sugar planter, there is seldom any need of buying this element in the form of fertilizers provided that a proper system of plant rotation and cultivation is practiced. It has been ex-

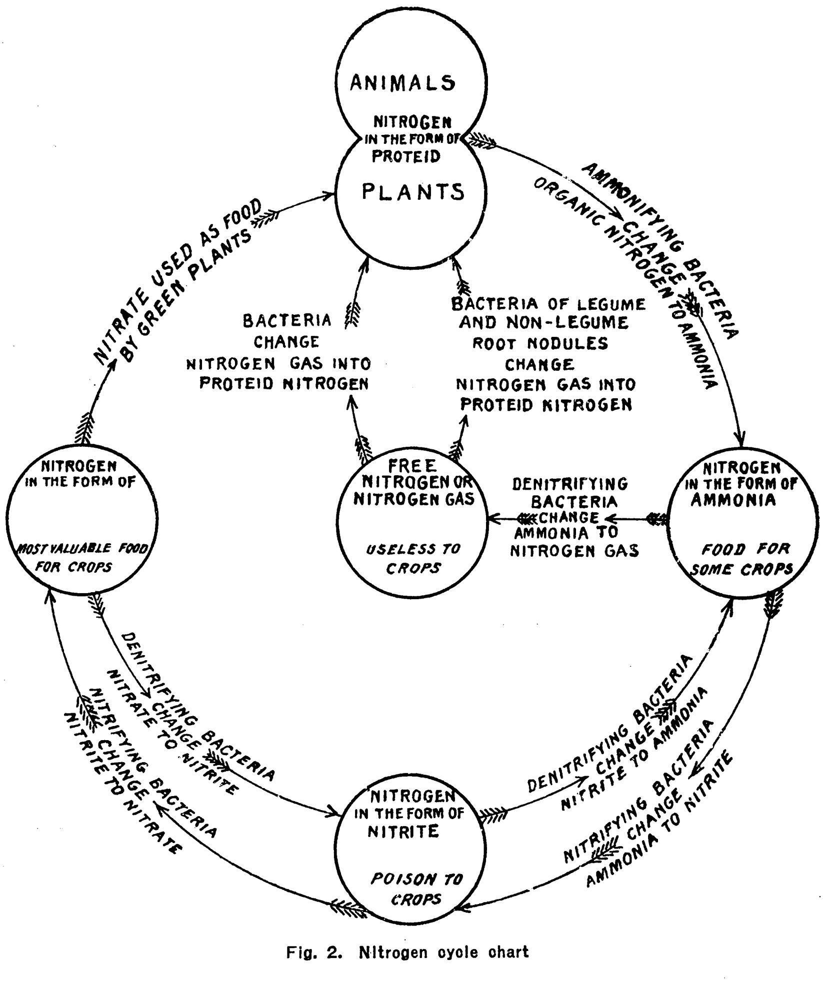


Fig. 2. Nitrogen cycle chart

plained that it is a comparatively easy task to deposit this material in soils by the aid of legumes and it is practically as easy to guard the supply from unnecessary losses by leaching and denitrifying bacteria if proper attention is given to cultural methods. In the discussion on soil bacteria the first problem will be explained, while the latter is discussed under soil drainage.

Fig. 2 indicates the cycle through which nitrogen passes in its course from the free nitrogen of the air to bacteria, thence to plant substances, and from this material to animal substances, and thence back to the soil. If conditions suitable to the growth of the beneficial organisms are maintained, the greater portion of this material will be changed to a form suitable to the cane and it will be gradually liberated as needed. On the contrary, if adverse conditions should prevail, the nitrogen will be changed to a form detrimental to the cane or it may even escape entirely from the soil as free nitrogen. There are bacteria of various classes present in all soils and those soils which are extremely fertile are usually found to contain these minute organisms in greatest abundance. While the fertility of soils does not depend entirely upon these bacteria, they perform a very important function and the mere fact of their existence is in itself evidence that organic matter is present and suitable cultural conditions obtained.

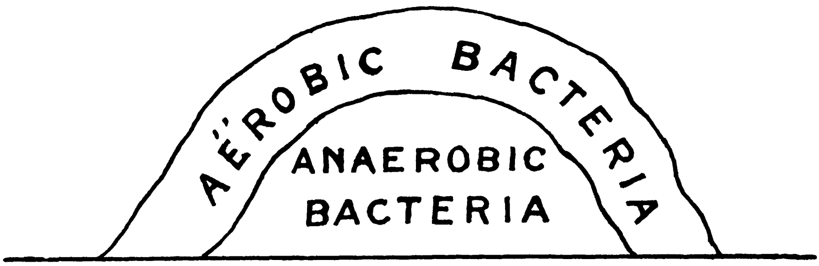


Fig. 3. Showing location of bacteria in decaying manure

Among the bacteria found in soils which are of special interest in conserving a supply of nitrogen are two general classes; namely, the aërobic, or those which flourish only in the presence of air, and the anaerobic or those which live in the absence of air.

The aerobic bacteria are largely responsible for maintaining the fertility of many soils by liberating nitrogen so that it may be used by plants. They change the pent-up nitrogen of organic compounds to an available form. Even the nitrogen present in many organic fertilizers must be acted upon by bacteria before the sugar cane can use it. It may be seen that this class of bacteria perform a very important function on sugar plantations; and since they exist only in the presence of air and act on organic compounds, conditions favorable to their activities should be maintained by the planter. This will include proper aëration of the soil, thorough cultivation and drainage and the presence of suitable quantities of lime to keep the soil neutral

and loose, in addition to the maintenance of a constant supply of organic matter. Another class of bacteria of interest to the planter are those responsible for depositing the free nitrogen from the air in the nodules of leguminous plants. When suitable conditions are not maintained with the soil, the denitrifying or anaërobic bacteria are able to thrive. These, instead of fixing nitrogen in the soil, liberate that which form is toxic to plants. So it is a poor practice to permit such conditions to exist in the soil that this type of bacteria will thrive.

Fig. 3 shows the location of those bacteria in decaying farmyard manure.

While the exact function of any one plant-food element in plant development is rather difficult to define, yet the importance of nitrogen in the growth of sugar cane is quite apparent when it is realized that practically every portion of the plant contains certain compounds in which nitrogen plays an important part, though the amount of it present may be small. One of the most important effects of nitrogen noted in the growth of sugar cane is that produced in the foliage of the plant. Other conditions being favorable for growth, an abundant supply of nitrogen in an available form will cause the leaves to assume a rich green color. This in itself is an indication of strong, healthy growth. On the contrary a lack of nitrogen or its presence in an unsuitable or toxic form will give the cane a yellowish, sickly appearance and the growth will be slow.

Sugar cane is a plant which instead of sending up but one stalk, as is observed with ordinary farm crops, produces a great number of stalks, due to the development of the buds on the rhizomes of the root-system. This veritable forest of cane that is produced annually requires a great surface area in its leaves in order that the function of respiration may go on properly; and while it requires a balanced ration of all the necessary plant food elements to account for the proper development of the plants there is no one element the function of which is more noticeable in this respect than nitrogen. This element likewise affects the age of maturity of the plant. It is a common belief among sugar producers that a supply of nitrogen in the soil will delay the maturing period of the cane and cause a reduction in the purity of the juice to result; but it has been the writer's experience that a suitable supply of available nitrogen, along with the proper amount of the other necessary plant food elements, other conditions being favorable, will cause equally as high or even higher purities to result than is possible where this element is lacking in the soil. This was proved in the ex-

periments conducted at the La Carlota Experiment Station during three consecutive years.

As regards the use of this element in safeguarding the health of plants, it has sometimes been remarked that insects and plant diseases affect sugar cane less where there is a large supply of nitrogen present in an available form. But in the writer's opinion any one element alone is able to accomplish little in this direction. As mentioned before, there must be a properly "balanced ration" of all the necessary plant-food elements in order to keep the plant in a strong, vigorous condition and thus able to withstand adverse treatment.

CALCIUM

This is one of the most common of all the necessary plant-food elements and forms approximatley one-sixteenth of the materials making up the earth's surface. On account of its active qualities while in the pure state, it is always found in combination with other elements. It ordinarily exists in the form of calcium carbonate or limestone and great deposits of this material are found in various parts of the earth where the rock is quarried for economic purposes.

The deposits are either of sedimentary, transported or organic origin. Sedimentary rock is deposited when calcium in one of the active forms meets with carbon dioxide, causing a new chemical compound, calcium carbonate, to be formed. Since this material is quite insoluble it is precipitated out of solution and deposited as more or less pure calcium carbonate. The Island of Romblon contains vast deposits of sedimentary as well as coral limestone which is extremely pure and will answer very well for the production of lime not only for application to soils but for clarification of cane juices as well.

Transported limestone is deposited by such agencies as winds and the flow of water. In this case, the rock is usually ground into small particles and deposited in heaps of loose material like that on the eastern coast of England which has furnished such valuable material for neutralizing the acids and loosening the heavy soils upon which it has been used for centuries.

Great limestone deposits of organic origin also exist in many places. These consist of the mineral remains of animal life such as the crinoids, corals, and mollusks which existed during by-gone ages when the lands were submerged.

Calcium, in one of its common forms, namely, oxide, hydroxide and carbonate, performs very important functions in maintaining the productivity of cane soils. These may be summarized as

chemical, physical, and biological. It would be utterly impossible to grow a crop of cane if there were no calcium in the soil, since this furnishes an essential constitutent of the plant; yet it is seldom if ever necessary to apply fertilizers containing this element, for most lands are abundantly supplied for that purpose. In the production of each ton of cane there is removed from the soil approximately one kilo of calcium. This material need not be lost, however, since it may all be recovered from the ashes of the burnt bagasses and from the filter-press cake when the by-products of manufacture are returned to the soil. As in the case of the other necessary plant-food elements, calcium passes through a regular cycle, year after year, being first dissolved by the soil waters, then taken up by the rootlets of the cane, and carried to the various parts of the plant, where it has a vital office to perform in the elaboration of sucrose, though it does not become a chemical constituent of that substance. The cane is then cut, the juice extracted and the sucrose, a pure carbohydrate with no calcium in it, is recovered. The calcium in the juice passes on to the molasses and filter-press cake, while that contained in the fiber is deposited in the ashes during the combustion of the bagasse and the two are returned to the soil ready to perform this important function in crop production another year, thus completing the cycle.

Material containing calcium is so cheap and so readily accessible, and the improvement, physical and biological, of soils treated with compounds of this element is so great, that it would be very poor policy to make calcium the limiting factor on a sugar cane plantation.

While sugar cane grows best on lands that have the proper amount of available plant-food material present, yet it is equally as important to maintain suitable physical conditions within the soil in order that all elements may be properly assimilated. Certain classes of clay soils form a plastic mass which is impervious to water, hence they are unsuitable for the growth of sugar cane until properly treated. Applications of lime on many of such soils will cause the soil particles to become granulated and assume a distinct form thus rendering the soil loose and porous.

The writer investigated clay soils on the Iwahig Penal Farm, island of Palawan, with the idea of employing them in the production of sugar. These lands had been planted to rice for several years but it was found utterly impossible to retain a supply of water over the rice fields within the bounds of the earthen dykes, notwithstanding the fact that this class of soil in which yellow clay predominates is usually very retentive. A

chemical analysis showed the soil to contain over 5 per cent of calcium compounds which had caused a flocculation of the clay particles and made the soil so porous that the water readily filtered through.

In order to produce large crops of sugar cane there must be proper circulation of the soil waters. This serves to prepare a sanitary home for the plant by removing through gravity and capillarity the water polluted by the oxidation of poisons of the plant. In addition to this, the movement of soil waters serves to carry a supply of soluble plant-food material from remote regions to the rootlets to feed the plant. Calcium also renders many compounds harmless to sugar cane.

Every fertile soil is filled with minute organisms known as bacteria. These perform very important functions in giving life to the soil and in preparing plant-food material in an available form. That these bacteria may thrive the soil must be in a suitable condition. Lime serves to neutralize the acids and sweeten soils thereby accelerating the activities of the soil bacteria.

Applications of lime on soils consisting of fine sand and silty material may cause them to become more retentive by cementing together the soil particles. Such soils are thus better able to retain moisture during a prolonged drought and the capillarity of the soil is materially improved.

The form in which the lime should be applied, the amount to apply and the time to apply it for best results are important problems of the sugar planters.

Calcium may be applied to cane lands in any one of the three aforementioned common forms, the oxide, hydroxide, or the carbonate, with equally good results; provided that not too much of the first-named form is applied at a time when the land is well supplied with organic matter, and that it is not placed in close proximity to growing plants. Where the carbonate form is employed, it is neceessary that more time be given it to act; hence it will give best results on soils which require lime more for the future than for present needs. The oxide and hydroxide forms give the quickest results and at least a limited amount of one of these should therefore be employed on extremely toxic soils in order to obtain prompt results. These, however, or at least the oxide, present the disadvantage of destroying the organic matter and thus may cause a loss of plant- food material, when applied in too large quantities. On account of the difficulty encountered in handling lime in the oxide form, the hydroxide or slaked form is usually preferred. This is prepared by leav-

ing it in the air for a while, which causes it to swell up and crumble into a fine powder. The carbonate is the safest form to use as it may be applied to all classes of soils and plants without danger of destroying the organic material; but it is slow in action, and can be used to advantage only on certain classes of soils.

The writer has obtained the best results in the use of lime on the majority of cane lands of the Philippines by making light applications of the oxide or hydroxide which is thoroughly incorporated in the soil. This is followed by a second and heavier application, using the carbonate form. A sufficient amount of the oxide should be added to neutralize the excess of acid and there is usally required for this at least 200 or 300 kilos and sometimes more per hectare, depending upon the amount of acid and other neutralizable toxic substance in the soil. Applications of lime in the form of carbonate should be made at the rate of two tons or more per hectare if it is desired to improve the mechanical condition of the soil as well. Usually it is more profitable to make a few heavy applications than numerous light ones.

ORGANIC MATTER OF CANE SOILS

It has been remarked that soils are composed of inorganic or mineral matter and organic matter.

The term organic matter refers to the tissues of both plants and animals. In the case of plants this material consists largely of cellulose, which is derived mainly from the carbon dioxide of the air and from water, while the small amount of mineral matter and nitrogen in plants are derived from the soil.

The application of organic matter to soils acts in a beneficial manner by supplying extra plant-food material, and in assisting in the liberation of plant-food elements from the rocks and soil particles. In addition to this it improves the texture of most soils, serves to retain moisture and provides a medium in which bacteria may thrive.

When organic matter becomes thoroughly decomposed it forms the dark-colored material known as humus. This contains the remains of the plant and animal tissues which are broken down by the process of oxidation, whereby the plant-food elements contained therein are liberated for the use of the plants.

The diagram in Fig. 2 indicates graphically the cycle through which nitrogen passes in being changed from the free nitrogen of the air into living forms of plants and animals, later deposited in the soil and finally returned to the air or reëntering plant and animal tissues. When organic matter is decomposed and

converted into humus, various acids known as humic acids are given off. These act upon the rock particles in the soil and liberate plant-food elements in the same way as would result if one of the stronger acids were applied to the rock particles, except that the process is slower. This is one of the wise provisions of nature to gradually liberate the plant-food material, little by little, as required by the plants, while at the same time the main supply is left in an insoluble form which is secured from the loss that would result from leaching.

The sugar planter who would learn the secrets of nature in maintaining soil fertility on his plantation needs only to go into the forest and there he will find a great carpet of organic material is deposited year after year. The lower portion of this mat has long since turned to humus and now forms the habitation of countless minute organisms that are very busy in preparing material to feed the plants. Virgin soils, which are universally classed by planters as being the most productive sugar cane soils, have been formed in this manner. The process by which they were formed seems extremely simple when nature alone is intrusted with the task, but when the land is cultivated and crops are produced year after year there is often noticed a gradual decrease in fertility due mainly to the fact that few planters profit by the example set them by nature and follows her methods. When a crop of sugar cane is harvested there is left remaining on the field a heavy coat of leaves and tops consisting mainly of organic matter like the mat of leaves found in the forest. After this material is decomposed humus is formed from the organic matter which is valuable to the plantation. It is the ruinous custom among planters of the Philippines to burn off this mat of leaves and trash after harvesting the cane in order to facilitate cultural operations. This treatment causes the organic matter to be entirely lost to the soil. While it is true that the land may be cultivated with less difficulty when this material is thus removed, there is experienced at the same time a fatal loss of the important organic material which would have enriched the soil. It will be shown later that the production of a soil is largely measured by the bacterial activities taking place within that soil and these are entirely dependent upon the supply of organic matter present.

It has been remarked that only carbon, hydrogen, and oxygen, elements of the air, and water are employed in the elaboration of sucrose in the form of finished sugar; the small amount of ash removed with the crop of cane may all be returned again as one of the by-products of sugar production. It seems unreasonable

that the fertility of the cane soil would be impaired greatly by crop production if proper methods were followed to conserve all of the by-products. In the first place there is no less than ten percent of the crop left on the soil in the form of tops and leaves of the cane. This is equal to the organic matter deposited yearly in many forests. If this material were left on the surface to decompose or were mixed into the soil it would perform almost as valuable a function in enriching the soil as the heavy coat of leaves do in producing the rich virgin soils of the forest. In addition it would serve to protect the soil from the burning rays of the tropical sun and thus prevent the loss of the nitrogen and moisture which are so badly needed on all sugar plantations. So long as this system, common in the Philippines, of burning off the leaves and trash after the harvest of the cane and throwing away the waste products at the factory, is practiced, the organic matter in the soil will continue to diminish until the soil is similar in appearance to a mass of mineral matter like brick and cement. Such a soil is in a dead condition, so to speak, and can never make a suitable home for any plant. Cane grown on such soils will have a bad color and yield smaller returns than would be possible on the same soil under favorable conditions, however thoroughly the cultural methods may be executed and however well prepared the soil may be.

It has been observed that cane soils containing a supply of humus from the previous crops are invariably in a better physical condition and therefore respond better to cultural operations than those without it. In comparing the cost of producing cane under the two systems, it must be taken into consideration that where the organic material is destroyed more irrigation water is required to replace that lost through evaporation by the sun and the heat engendered by burning the trash; valuable nitrogen is lost through the destruction of the organic compounds containing same and, in addition, it is impossible to maintain suitable conditions for the development of the bacteria which give life to the soil. All of these items are important and more than counterbalance the extra labor necessary in preparing the soils obstructed by this trash. It has been the writer's experience that ratoon crops produced with trash left upon the ground require less than one-half as much cultivation as that required on the burned fields, and that a better stand of cane invariably results. One of the essentials in the development of the rhizomes of sugar cane is to have a moist, loose soil about the root system. This condition can be maintained most readily where

there is shade over the ground such as that produced by a heavy coat of cane leaves and by having incorporated in the soil a supply of organic matter and humus.

SOIL BACTERIA OF CANE LANDS

The subject of micro-organisms in soils is very important to sugar planters, for these organisms are largely responsible for the fertility of various soils. Soil bacteria may be considered as the connecting link between plant and animal life and indeed it is through their activities that the tissues of various plants and animals are broken down and the plant food material is converted into a form to be used by the plants. It is these minute organisms that give life to the soil and prepare a suitable home for plants.

There are an astonishingly large number of bacteria present in soils. Not all of these, however, act favorably in their enrichment but the majority of them are beneficial. It has been found that upwards of 50,000,000 of these bacteria are often present in a single cubic centimeter of fertile soil where conditions were favorable for the development of the bacteria and the production of plants.

It may be readily understood why the surface soils are often highly fertile and the sub-soil is apparently in a dead state and fails to produce large crops, when it is considered that the greater percentage of the micro-organisms and approximately 65 per cent of the total nitrification occurs in the upper thirty centimeters of the soil, 30 per cent in the next half meter, while beyond that depth very little of this important work of nitrification goes on.

Experimentors have found that crop yields are usually proportionate to the number of bacteria present in the soil, and that the lands most plentifully supplied with humus or decomposed organic matter contained soil bacteria in the greatest abundance, while those fields containing the lowest percentage of organic matter had the smallest number of bacteria. It has been conclusively proven that an abundant supply of available nitrogen is necessary in the production of large cane crops and that bacteria are largely responsible for fixing this material in the soil. It is therefore evident that the problem of providing a suitable medium in which the nitrifying bacteria may exist should be given serious attention by the sugar planter.

Among the numerous classes of bacteria found in soils, may be mentioned two which deserve particular attention. One of these is responsible for changing plant-food material to a soluble

form which is suitable for plants, while the other has the power of transforming soluble forms of nitrogen into a form unavailable to plants.

The first type, or aërobic bacteria, exists only in the presence of air and thereby obtains the supply of oxygen required in bringing about the transformation of the nitrogen in the soil. The other class derives its oxygen from that contained in organic compounds which it causes to be broken down. This class of bacteria is known as anaërobic bacteria. Since one of these classes of bacteria acts in a beneficial manner and the other acts detrimentally to the soils, the problem of maintaining the conditions in the soils favorable to the beneficial class should be given attention. It is therefore obvious that the first step is to have the soil in a well aërated condition. Anything which increases the porosity of the soil permits the air to enter in greater volume and favors the growth of these bacteria. This condition of the soils also permits the entrance of sunlight and consequently causes the soil to be warmed, which is beneficial to the growth of the bacteria when lands which lie follow.

The application of lime often assists in improving conditions for the development of bacteria by sweetening the soil and causing granulation or flocculation of the soil particles.

Nitric acid is one of the compounds resulting from the activities of the aërobic bacteria and when the nitrates become too abundant the conditions are unfavorable to the growth of these bacteria, while at the same time they become favorable to the denitrifying form, which have the power of changing the nitrates into nitrites, ammonia and even free nitrogen, so that it becomes unavailable to plants. The action of lime on soils heavily laden with nitric and nitrous acid serves to produce salts of these acids and improves conditions for the nitrifying bacteria.

Another thing of importance is to provide a suitable medium in which they may live. For this purpose it is important that organic material be present in abundance. As explained under organic matter, this may be supplied by growing and turning under various crops and by returning to the soils the various by-products from sugar plantations. One of the best materials to use is filter-press cake from the modern factories. In regard to the application of molasses for this purpose it has been rather a disputed question as to just how much value may be attributed to this material. The writer has experienced that on many of the well drained lands of the Philippine Islands extremely encouraging results were obtained when this material was applied

in the irrigation water, at the rate of two or three tons per hectare; while on those which suffered from improper drainage, as well as on lands the acidity of which had not been properly neutralized, the material was detrimental rather than beneficial. The analysis of average exhausted molasses shows that the nitrogen content is a little more than one-half of 1 per cent and the total ash content but slightly greater. The low percentage of these fertilizing elements would indicate that any increase in crop yields did not come from these fertilizing elements alone but rather from other sources, since the application of these elements in such small quantities in any other fertilizer fails to give appreciable results. Extensive experiments have been conducted in Mauritius with this material and it was found that an increase of upwards of 12 tons of cane per hectare was obtained up to the third ratoon. This would indicate that on those soils the effect of this material might be noted for a long time.

It is presumed that molasses acts more as a soil renovator and performs other functions than only that of supplying the plant-food material it contains. It is not improbable that the residue from the carbohydrate material present furnishes a suitable medium for the beneficial or nitrifying bacteria on the well drained soils. It is to be presumed that the effect of molasses on the development of nitrifying bacteria may be of a similar nature to that performed by sugar as described in Berthelot's experiments.

Where molasses is employed as a soil renovator, precautions must be taken in its application, since this material may have a detrimental rather than a good effect. It has been pointed out that in soils where the nitrifying bacteria are active the denitrifying class are at work as well; and while some of the conditions are favorable to both alike, yet there are others which are directly antagonistic to the development of the latter class of bacteria even though they favor the former. Since an abundant supply of oxygen is essential to the activities of the former, and detrimental to the latter, it follows that molasses will give the best results on well aërated soils. It also follows that it would not be well to apply this material to lands which have their nitrogen in the form of nitrates, as this form is readily acted upon by the denitrifying bacteria, and this causes the nitrogen to be lost from the soil.

It has been explained that although plant tissues may be well supplied with the various plant-food elements this material is entirely locked up from the use of other plants until liberated

by the aid of nitrifying bacteria. The planter is in fact indebted to this class of bacteria to convert the plant-food elements into an available form in such fertilizers as tankage, cottonseed meal, bone meal, and copra meal and indeed even in stable manure, and filter-press cake. It is fortunate that he can control conditions, however, so that the class of bacteria which act favorably to the plants will predominate over the denitrifying or unfavorable class.

Nitrogen is the plant-food element most easily lost in nature through leaching and this is especially true with reference to the Philippines during the rainy season. It may also be liberated and escape in the free state through the decomposition of the various compounds.

The amount of nitrogenous matter consisting of albuminous bodies, pectin, and the like contained in cane averages from 0.5 to 1 per cent. The nitrogen in this case is derived entirely from the soil, since sugar cane is not a nitrogen gatherer.

KINDS OF SUGAR AND HOW MADE IN THE PHILIPPINE ISLANDS

By C. W. HINES, *Sugar Technologist*

There is perhaps no country of the world where so many different kinds of crude sugar have been produced on a commercial scale as in the Philippine Islands. This no doubt results from the fact that early sugar producers here were descendants of widely different countries and each was eager to produce a sugar meeting the desires of his own countrymen. It is possibly true also that systems used in his own country were the only ones familiar to him and even though he might wish to conform to the desires of the people with whom he cast his lot it was not by any means a simple task for him to change from his system which required years of hard work and experience to learn the art of sugar making by the rule of thumb method prevalent in those early days to another which to him was as difficult and complicated.

Another thing that contributed toward the making of certain specific classes of sugar was the lack of commerce with foreign lands. The commerce of very early days consisted largely of trading among groups of oriental islands and with the Mongolians on the Asiatic coasts. This naturally brought many immigrants from China who later became permanent residents of the Islands, and just as the people cf their fatherland desired foodstuffs like those to which they were accustomed and sugar was no exception to the rule so those who settled here desired the same kind of crude sugar to which they were accustomed. As time went on and better means of transportation were available, commerce was started and inhabitants of more distant countries arrived, perhaps at first only as adventurers but later they took up their place of abode here. These had their own tastes but were experts in manufacturing the products to which they were accustomed. They had settled here and they also saw the opportunities of trade with their mother country if their products found favor in the homeland. The earliest of these people to arrive here and enter the sugar industry on a commercial

scale were the Chinese and so persistent have they been ever since in following their customs and traditions of early days that the systems they first introduced are common to this day in various sections of the Islands.

The next to enter the field were the Spaniards. Their systems in early days were very crude, in close keeping with the custom and of the demands of the time. They used a system of boiling their sugar analogous to that of the Chinese but their crushing plants, and their finished sugar differed somewhat. And while they made a little progress, especially in the way of improving and enlarging slightly their crushing plants they employed the same general system throughout the history their little sugar industry, and they continued making the same low grade molasses laden open kettle sugar so long as they retained control of the Islands.

The next people to enter the field of sugar production on a commercial scale were the Americans and with them they brought real progress. At this time the Filipinos also were induced to branch out in the field of sugar production more extensively than ever before and today there are a number of sugar companies organized and financed entirely by Filipinos. Long since sugar had become a general food stuff and was in great demand all over the world and the fastidious consumers had reached a point whereby they were no longer content with the low-grade dark-colored, crude sugar which met the trade of former times but by this time they demanded a clean light colored sugar, free from the bitter caramel of old and possessing only the sweet and the characteristic pleasant flavor to pure cane sugar products.

METHOD OF BOILING THE JUICE

The general custom of making all of the various classes of crude sugars from the time sugar production was first started as a strictly home industry until the introduction by the Americans of modern centrifugal factories was that of boiling the juice in either earthen containers or iron kettles over direct fires until the necessary consistency was reached, when it was taken from the fires and treated in the necessary manner to make the class of sugar desired.

The system of clarifying the juice was very inefficient. In fact it is doubtful if in many cases the purity was not reduced rather than increased for the lime that was used as a clarifying reagent often contained quantities of insoluble matter such as

sand and unburned carbonate rock and as the juice was never strained nor filtered after the introduction of the lime there was no chance of removing this material once it had been applied. In later years as the industry became more important and the crude sugar was made on a commercial scale, larger kettles were used for boiling the juice and in some cases a receptacle was arranged into which the skimmings were discharged and left for some time to settle so that not only a saving of the sugar was affected but the juice resulting from this crude settling apparatus was at least free from the heavier portions of the insoluble material and it was also freed of some of the lighter colloidal material as well.

Just as today it requires experts in their line to efficiently handle the various processes through which sugar is passed during its manufacture, so during the days of the open kettle muscovado sugar it required masters called "maestros" to handle the most important station, that of boiling the sugar, and this man was presumed to possess next to supernatural powers in the art of sugar making as a result of his years of experience and practice. His supposed ability to remove the boiling sugar at exactly the time when it was "just right" and perform certain mysterious movements which induced the sugar to crystallize properly and turn out "good" made him the chief of the sugar house. If for some reason or other fate happened to be against him and the sugar turned out to be wet and bad, according to his explanation, it invariably had resulted from an act of "Dios" or on account of the bad cane, but never was it thought to have resulted from a mistake of the "maestro."

It depended upon the progressiveness of the owner, his financial ability and his desire to advance to the then modern whether the juice from the cane was extracted by means of little mills consisting of wood, stone, or iron rolls. The juice was passed from the mill to a receptacle near the kettles by means of tubes of bamboo or other material. The number of kettles used in boiling it depended upon the amount of cane the mill was capable of grinding. If a small wooden mill was used only one or two kettles might be employed, while if it was one of the larger steam driven mills like those employed in the later eighties it might consist of a number of batteries each containing from three to five kettles. The juice was dipped into these kettles by means of long handled ladles and as boiling progressed it was dipped from one kettle to another, so that it was finished in a certain kettle which might be the second from the front or the third from the last depending upon the whim of the "maestro."

Crude lime was dissolved in a little boiling juice taken up in the ladle and added from time to time as necessity demanded as determined by his sharp eye and keen old factory nerve. The light impurities which came to the surface were skimmed off by means of a shallow skimmer made of a band of bamboo covered with coarse abacá cloth.

The boiling was continued and the juice dipped from kettle to kettle and finally concentrated in the special kettle where it was designated by the maestro that the finished sugar should be made. When the "punta" or point of the heavy mass at which the finished point of the sugar was reached, which was determined by the maestro feeling, tasting, or smelling, and sometimes by all three means, a sample of the boiling sugar taken up in a certain special manner, the boiling mass was removed from the fire and made into the special kind of open kettle muscovado sugar desired. Pilon Sugar.

Where the Chinese or "pilon sugar" was desired the boiling mass upon nearing the crystallization point was dipped into pilons, bell-shaped earthen jars each about seventy centimeters high and fifty centimeters across the top and holding about one hundred and twenty five pounds of finished sugar. These containers had a hole in the bottom about five centimeters in diameter for the purpose of allowing the molasses to drain away after crystallization of the sugar was well advanced. The jars were set in soft earth when the hot mass was first dipped into them to prevent it from escaping through the hole in the bottom of the pilon. The contents were stirred constantly with a small, specially made, shovel-like instrument in order that the mass might begin crystallizing at the same time throughout when the temperature had sufficiently lowered and conditions were favorable for the sucrose in the super-saturated solution to crystallize. The jars were left in this condition until the sucrose was well crystallized and the purity of the molasses was somewhat reduced after which they were set over smaller earthen jars for the molasses to drain away from the crystals. Where a still better grade of this sugar was desired, after the molasses had drained away and the crystals had become somewhat dry and hard, layers of banana leaves or a covering consisting of about a half inch of clay was placed over the top. This was kept moistened with water which softened the molasses still adhering to the surface of the crystals and permitted it to drain away. Clarified pilon sugar like a great deal of the other pilon sugar not receiving that extra treatment, was cut

into small blocks and used either locally or sent to China and sold for direct consumption. Although pilon sugar was originally made in the Philippines by Chinese and no doubt formerly used exclusively by them, in later years this became a popular product among the Filipino population of the Islands and great quantities were even used at the local refinery after it was started in the early eighties. In fact it was preferred by them to other types of muscovado sugar, it being of higher purity because the molasses had been removed. In fact it was the only sugar then produced in the Islands that was molasses free.

Caramelo sugar.—The manufacture of this semi-refined sugar for local consumption is an industry conducted exclusively by the Chinese both here and on the China coast.

The upper portion of the pilon sugar which is the lightest and purest is dissolved clarified by a mixture of albumin of eggs and lime and boiled to the crystallization point in shallow copper pans after which it is stirred vigorously until the mass is light and porous and crystallization is complete.

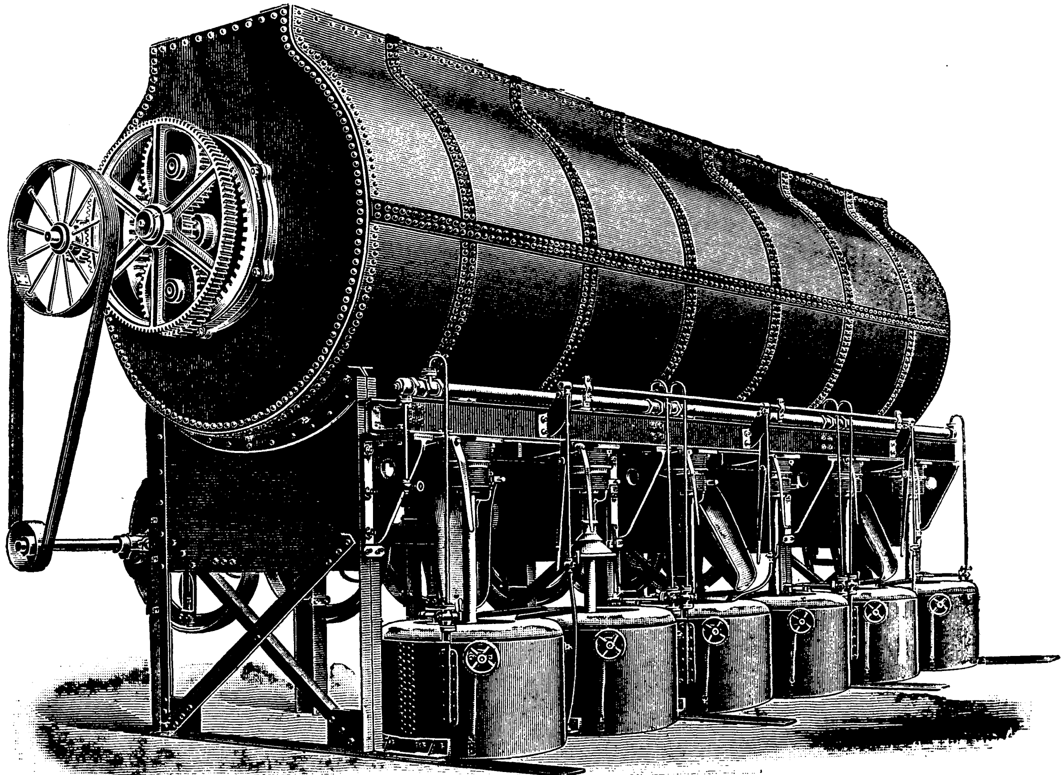
It is then cut into blocks about two by one and one-half inches by one half inch and packed away in large earthen jars, ready for market.

Panocha sugar.—This is merely open kettle muscovado sugar made directly into sugar cakes for local consumption. Only the best grade of cane, that yielding juices of high purity, are used in making this class of sugar.

Instead of the thick boiling mass being dipped from the kettle it is lifted off bodily and stirred constantly during crystallization and cooling, and when the mass becomes well crystallized and firm it is moulded into half round cakes by the aid of coconut shells. These sugar cakes are then packed in large bamboo baskets and carried to market or to the storeroom to wait marketing.

Bayong or mat sugar.—Of later years by far the larger percentage of the open kettle sugar has been made into this form.

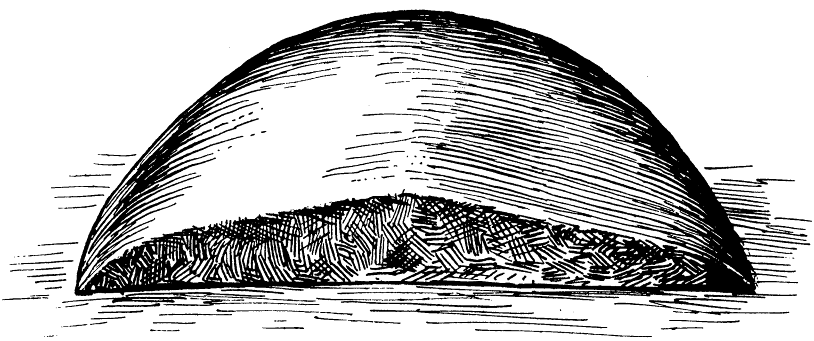
In making this sugar the heavy boiling mass is left on the fire until evaporation is so far advanced that the sugar will crystallize immediately upon cooling slightly. When this point is reached the sugar is dipped from the kettle and by means of wooden troughs conducted to large shallow wooden boxes or trays where it is shoveled about and all lumps pulverized by pounding with shovels. This sugar answered for the trade of the refineries formerly when centrifugal sugar was more scarce and somewhat difficult to procure in sufficient quantities, but



Modern "Weston" centrifugal machines massecuite mixer used in sugar work

Pilon sugar (open kettle), molasses—free sugar

Pilon sugar set over earthen jars for the molasses to drain away



Panocha or sugar cake

since the advent of modern centrifugal factories, it is only accepted when centrifugal sugar can not be had.

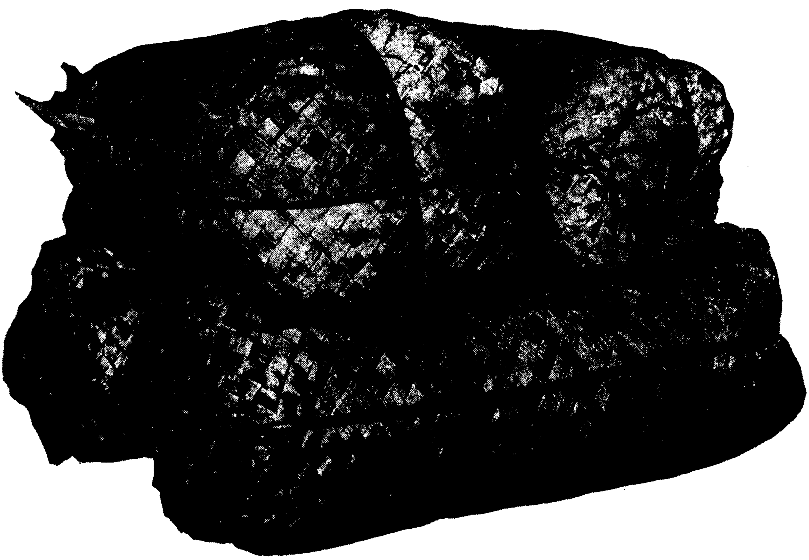
Centrifugal sugar.—This is the type of sugar made on all of the plantations equipped with modern factories. The standard polarization of 95° is the grade to which centrifugal sugars are universally brought when intended for high grade sugars for use in the refineries. It is a question of only a few years until all of the sugar manufacture on the plantations in the Philippine Islands will be of this type. Such sugars are manufactured into high grade granulated sugar at a minimum of expense due to the small quantities of impurities they contain. Where a semirefined, or plantation white, sugar is desired for direct consumption instead of 96 sugar the same factories sometimes turn out a sugar testing between 98 and 99 and possess the charateristic flavor of pure cane sugar products.

In addition to the above kinds of sugar all of the various grades of refinery crystals are made at the one small refinery operating in the Islands.

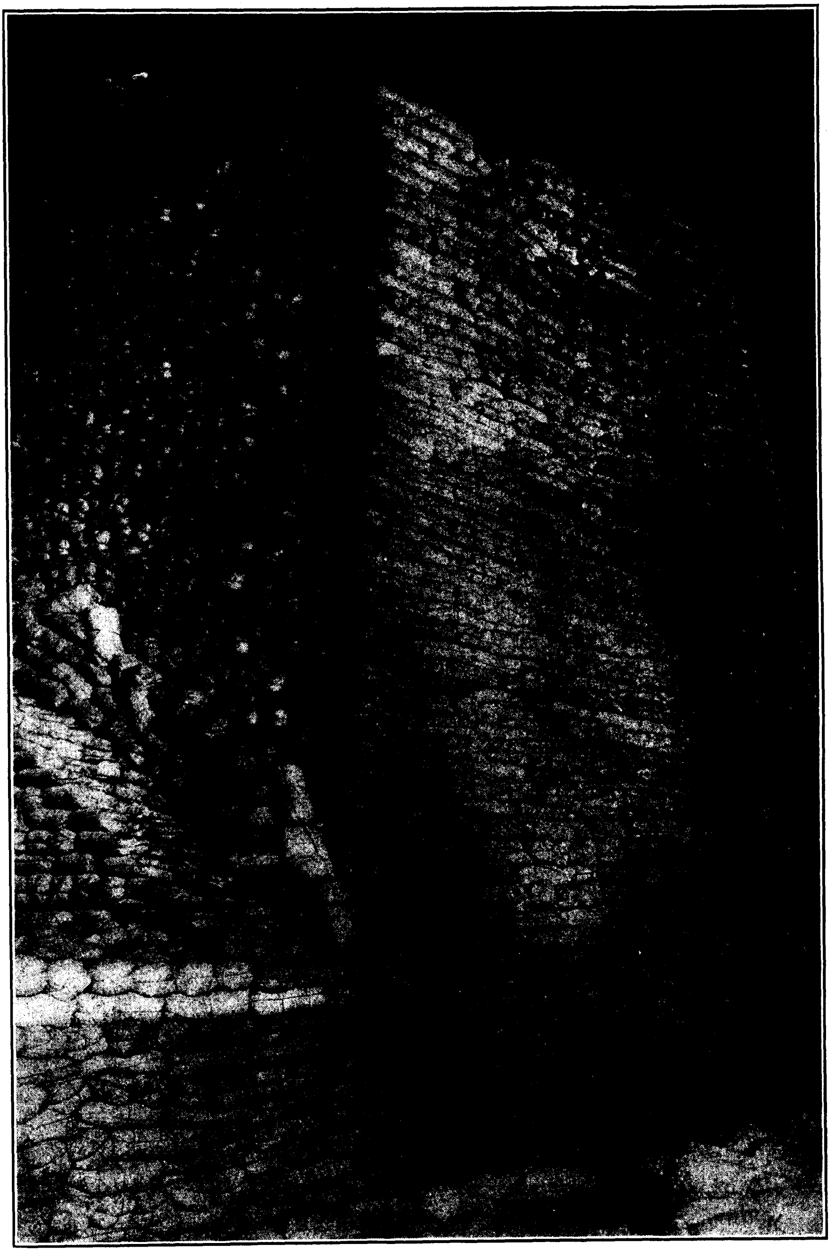
PLANT MATERIAL FOR SUGAR PLANTATIONS

By C. W. HINES, *Sugar Technologist*

In order to produce a good crop of sugar cane there are a number of essentials that must be given attention and foremost among these is that of plant material. Nature has provided three different means for the propagation of sugar cane. In common with the majority of plants, sugar cane produces seed which can be used for planting and indeed it is through this means that the numerous varieties under trial at the various experiment stations were originally produced. But since sugar cane does not consist of stable varieties, its seed will not, in all cases produce young plants with the same characteristics as the parent plant and in consequence a great number of new and distinct variations may result from the separate and distinct seeds of single plant. This is why such cane is called "variants" and not "stable varieties." If the flowers were cross-pollinized generation after generation in time no doubt a variety would be produced that would come true to the plants from which the seeds were taken the same as results with the various cereals. This trouble of producing stable varieties however need not concern the sugar planter for he is provided with a means of propagating the same kind of cane year after year almost indefinitely by means of scions or cutting (often called "points") from either the stalks which are produced above ground or the rhizomes from the root system; and the mere fact that the seed of a variant does not come true to the parent plant leaves a ready means of producing new variants. While many of them will turn out to be of a poorer class than the parent plant there is always the possibility of producing one that is far superior. Then when a menace becomes apparent like the Lahina disease in Hawaii which threatened the sugar industry there a few years ago, the scientists have only to set to work to produce new variants and select from them an "H 109" or some other new cane that is not only immune to the malady but may have even more favorable characteristics than the one it is to replace. It is a common belief among many planters that by analyzing individual stools or even stalks of cane and using for



Bayong or mat sugar



Bayong or mat sugar in a warehouse at Manila

A field of oane with outtings harvested

plant material cuttings from those stalks which show a high sucrose content there will eventually be a great improvement in their cane. Again others would practice plant selection for seed material by using only those plants which are robust and show a large growth. It is true that remarkable results have been obtained in improving the various cereals in this manner but it was where there was cross pollination among the plants, so that the new plant grown from the seed partook of the good qualities of both the parent plants; but in the case of the sugar cane the plant grown from a scion or from a rhizome is merely a continuation of the old plant.

Selecting plant material.—In selecting material for planting, the points of each kind of cane should be planted by themselves, for there are certain characteristics peculiar to each, such as the time of maturity, ratooning power, etc., which make it desirable to have them planted separately. Where one kind of cane matures earlier than others, all of the cane of that tract will be of practically the same stage of maturity, and, where it is desired to have a late cane for the last of the milling in addition to planting a portion of the cane later than the other, that cane which matures late may be used. Likewise with reference to ratooning some kinds of cane produce small root systems and ratoons very poorly yet they have other characteristics in their favor that makes it desirable for them to be retained. Again others produce large root systems and ratoon remarkably well. Obviously it would be a very poor policy to permit such cane to be planted indiscriminately in the same field.

Contrary to the general opinion of many planters there is no chance of improving the various kinds of cane by planting them together so long as cuttings are used for propagation, and at the same time there is no danger of producing inferior cane thereby.

It is only the green or immature portion of the cane that will answer well for plant material. If it is desired to greatly extend the planting, the entire stalks of green cane may be used as plant material equally as well as the tip or point of the mature cane; but in this case the cane should be cut at the age of seven or eight months, in a climate such as that of the Philippines.

In fact it is a general method of extending the plantings in the southern part of the United States, in Argentina and other subtropical regions where cane is grown by means of the entire

immature stalk, for in those countries cane never reaches maturity.

Where the plant material is removed from the upper part of mature stalks intended for milling purposes, care should be exercised that the points be not cut too low thus including an excessive amount of the mature woody material, nor yet too high so as to include the uppermost or top bud. The point should be cut low enough so that the circular stalk itself may be clearly

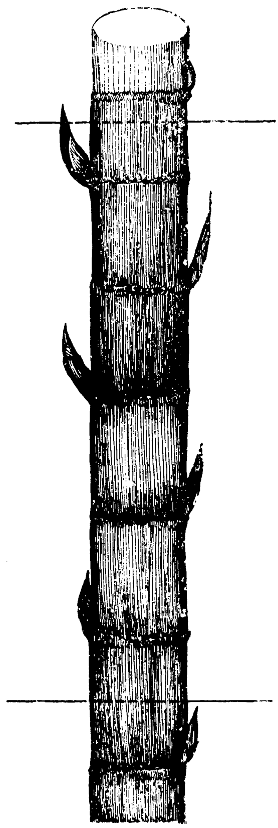


Fig. 4. Cane point properly cut

seen at the place the incision is made. This precaution is taken since the upper bud would quickly develop to the impoverishment of all the others. Figure 4 is a view of the top point properly cut.

Fig. 4 shows a cane point properly cut.

Each cutting or point should contain not less than three and preferably not more than eight good eyes or buds. Where the cane is quite immature two cuttings may be taken from each

stalk, otherwise there would be a sacrifice of cane suitable for milling and the employing of material that is too old for planting unless special treatment is given. But where the cuttings are thrown together indiscriminately during harvest, it would be very difficult and would necessitate much extra work to properly separate them and give them the proper attention.

When the cane is planted early in the season while there is plenty of moisture in the soil and while there are frequent showers, the newly cut points may be husked and planted immediately, without preliminary soaking, if favorable growing conditions can be obtained. But when the soil is dry and the cane from which the cuttings are taken is mature, it is imperative that the points be soaked to induce germination of the buds.

Soaking of the points.—The points should be soaked in clean fresh water; they must never be left where the water can stagnate.

A river or small stream usually provides the best place for doing this. In case there is but a small current of water the stream may be dammed up with loose material such as straw and cane leaves to check the flow of the water and raise its level while at the same time permitting it to gradually seep through thus resulting in its being constantly changed.

Where such a system is not feasible on account of excessive water passing through or the danger of losing the points from an occasional flood, it is sometimes possible to arrange a satisfactory soaking place for the points by diverting a small portion of the water into a depository where the points are placed, by means of a side channel, and again returning the water to the stream lower down. Another plan is to select a shallow place near the side of the stream where the current is sluggish and by means of stakes prepare a small depository for their protection.

If this is impracticable vats made of either cement or wood or even excavations dug out the firm earth may be used. In case running water is not available the vats may be filled and emptied at least every twelve hours and preferably every six hours. Another plan of soaking points that has certain favorable features is to spray the warm water from the condensor system of the factory on to the points. Underneath an arrangement of perforated pipes or troughs which constitute the spraying system the cars of cane points may be left standing until the soaking is complete, or the points may be dumped in piles where the warm water constantly falls upon them in the

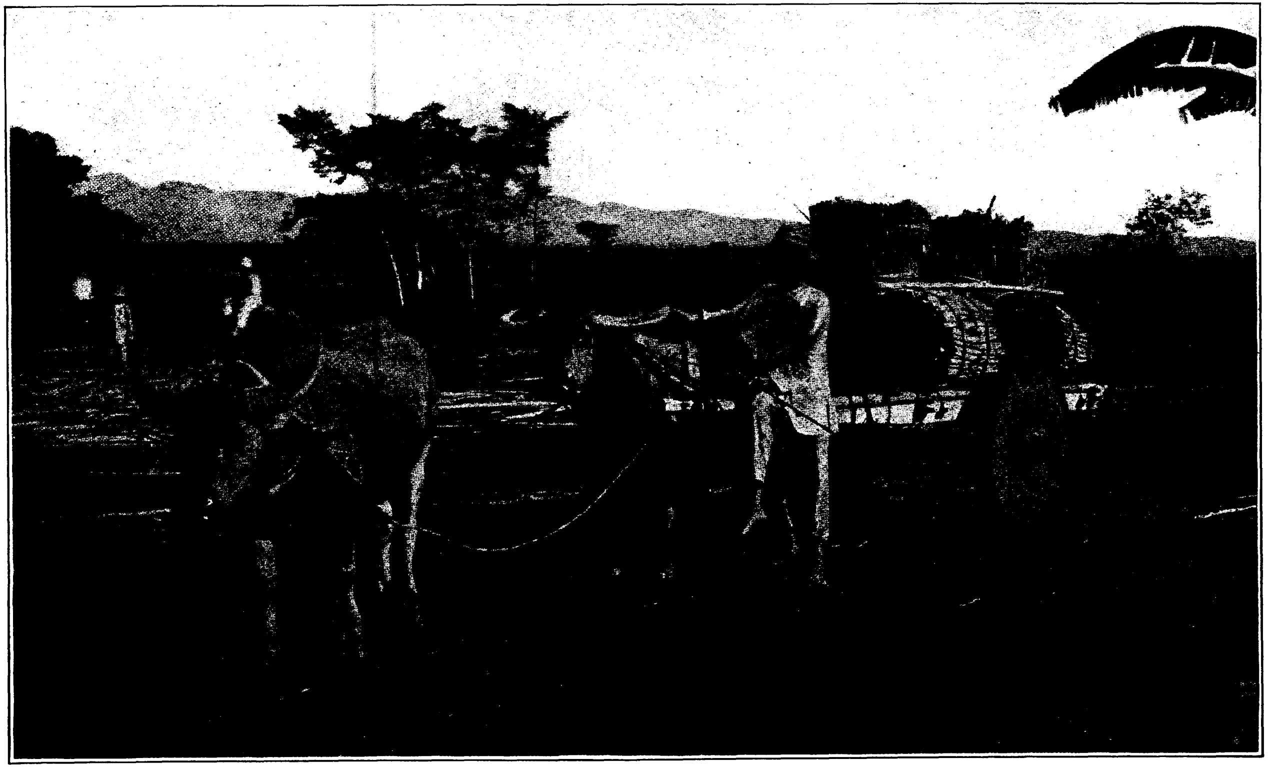
form of a spray. This system causes the buds to start much sooner than does the river soaking on account of the higher temperature of the water that is used, and in many cases it induces the germination of buds on points that would otherwise be thrown away.

When plant material is scarce and it is desirable to sacrifice the entire stalk in order to get sufficient material for planting it is well to remove several cuttings from the uppermost part of the stalk and these together with the lower portion or main stalk are put to soak. After a period of two or three days the buds near the top of the main stalk will have swelled out and started to grow, due to the sap of the stalk moving toward the top and inducing their growth. Another cutting may be removed and the main stalk again returned to the soaking place. This system may be repeated until the buds on practically the entire stalk are well started and none of the material need be discarded even though the cane was quite mature and the tissues were somewhat woody.

After the points have been soaked sufficiently, they should be taken out of the water and piled in shaded places where they are covered with leaves and trash for a couple of days during which time they are kept damp, for the buds to swell out and start to grow.

Husking the points.—When the buds are well developed, ranging in size from the more firm ones which will have only swelled out, to those which were already partly developed before the stalk was cut, and are now possibly three or four centimeters long, and the rudimentary roots also are either partly developed or at least show signs of beginning to spring forth, the husking is done. The purpose of this operation is to remove the leafsheaths so that the buds may develop into new stools of cane unmolested. During this operation any points the bud of which do not show satisfactory development are discarded. Figure 2 shows a cutting after the leafsheaths were removed and was ready for planting.

Planting the cane.—The cane points are taken from the damp piles in the shade and carted to the field only as fast they are needed for planting. This insures their being covered with moist earth, otherwise they would dry out, which would be detrimental to the life of the new plant. Plate IX shows a view of the method used of carting cane points to the field for planting. While cane is most generally planted by hand, there are



Transporting cane points to field

several machines on the market that bid fair to supplant the great amount of hand labor required in this work.

In planting by hand the well prepared land is furrowed out in rows about one and one half meters apart by such an implement as a middle buster, attached to which is a subsoiler which thoroughly loosens up but does not turn over the sub-soil at the bottom of the furrows. The cane should be planted as soon as possible after the furrows are formed. In fact it is better to have the planters always keep up with the furrowing out gang, thus permitting the points to be planted and covered without the escape of an excessive amount of moisture. Where labor is plentiful and cheap the cuttings may be planted by the operator showing each cutting into the soil at an angle of about forty-five degrees and pushing it into the ground with heel until only the top is exposed. A small covering of light earth is then applied. Some prefer to lay the points flat in the row and cover them completely with a layer of fine earth.

Although the new stalk which develops from the bud will find slightly less difficulty in reaching the surface when the cutting is placed at an angle, there is really little in favor of that system over the system of flat planting and where the soil is very loose and dries out badly the points placed on an angle will suffer slightly more for there is always an air-space around the point through which moisture may escape.

Plate XIV shows a view of a field of cane the cutting being planted on an angle. Where labor is scarce and there is much land to be planted the simple implement shown in figure 3 is very useful. To make this implement thoroughly effective a sub-soiler can be attached beneath the plow which loosens up the sub-soil for some depth below the place where the cane cuttings are deposited. It is sometimes necessary to make fairly deep furrows ahead of this planter in order to insure the cane being placed to proper depth. A timing arrangment may be attached to one wheel to indicate the time at which the points must be dropped, thus insuring uniformity in the distance of planting. From two to three hectares of cane may be planted per day by this implement, which carries its supply of points, plants and covers them by the aid of one animal or a tractor and two or three laborers. It therefore does the work of thirty to forty laborers the majority of whom are usually women and children.

Plate X shows a view of furrowing out and distributing cane points by means of cable plows. This system insures the

making of furrows to any desired depth and saves some labor in hauling and distributing the cane points.

Depth of planting the points.—Cane soils in addition to being properly plowed should have their subsoil broken up by the aid of appropriate implements for that purpose. This permits the cane to be planted to sufficient depth for the large stools to withstand the storms and be kept from blowing down when the land is wet and soft and the foliage of the plant is heavy. It also permits the root system to be located deeply to within reach of an abundant supply of plant food material and

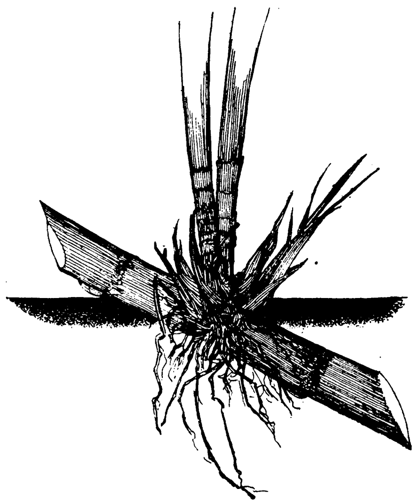
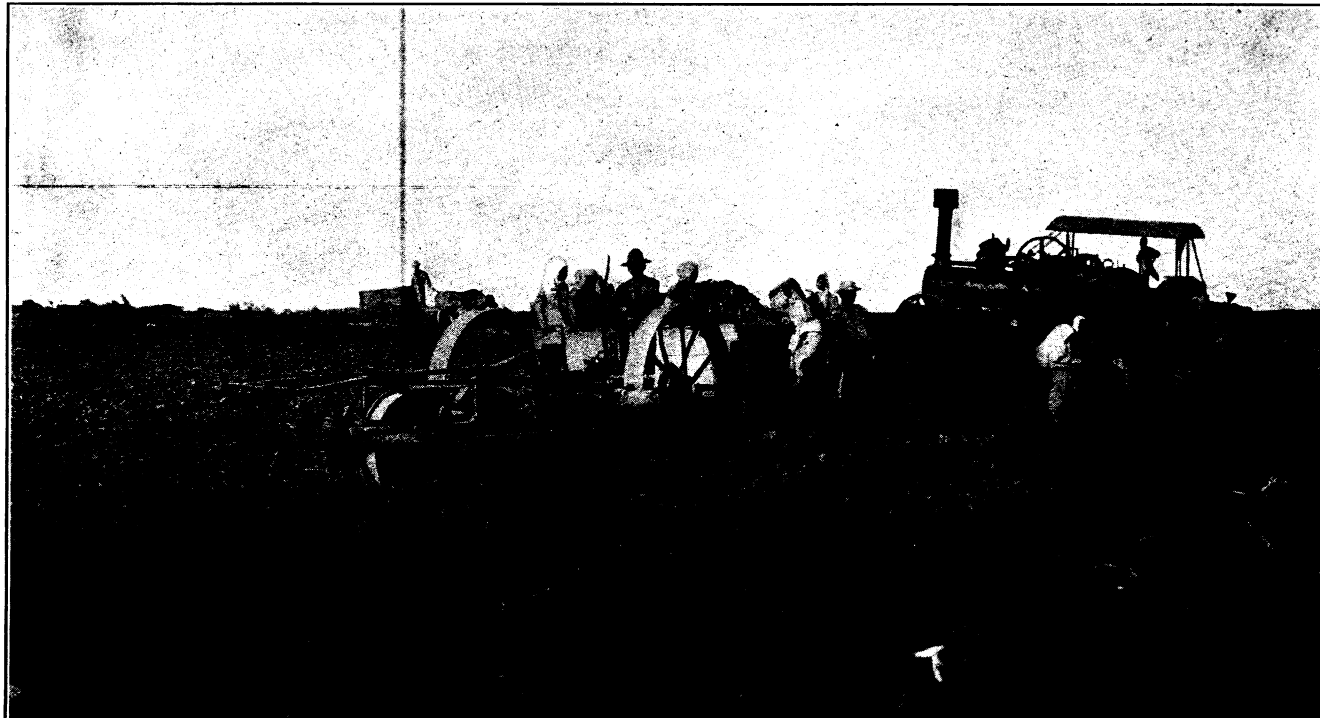


Fig. 5. Cane point six weeks after planting

moisture. Plant food elements are of no use whatsoever to plants unless they are in a dissolved form, for only in this condition can they be assimilated by the plants; so even if they could be carried to within reach of the plant in an undissolved condition they would be of no benefit to them except perhaps in a mechanical way.

Where the lower stratum is properly loosened so that the roots can easily penetrate it, they will extend to a very great distance into a region which not only is uncontaminated by plant toxins but where there is an abundant supply of moisture at all times.

Fig. 5 shows a view of a cane point with rootlets penetrating downward six weeks after being planted.



Furrowing out for sugar cane by means of cable plow

THE MANUFACTURE OF TABLE SYRUP

By C. W. HINES, *Sugar Technologist*

Syrup is one of the most wholesome of foods and is also one of the cheapest and most convenient to handle of all the forms in which sucrose and invert sugar are found on the market. During the process of digestion, sucrose is first split up into two sugars known as invert sugar or glucose and fructose by the enzyme invertase contained in the intestinal juice, before it can be assimilated. The following equation indicates the change which takes place:

$$\begin{array}{l} \text{Sucrose Water} \\ C_{12}H_{22}O_{11}+H_2\,O \text{ enzymic action} \end{array} = \left\{\begin{array}{l} C_6H_{12}O_6 \\ \text{glucose} \\ \text{dextrose} \end{array}\right. + \left\{\begin{array}{l} C_6H_{12}O_6 \\ \text{fructose} \\ \text{levulose} \end{array}\right.$$

In case the sucrose has already been crystallized the crystals must be dissolved before even the enzymes can act upon it. Preparing the sucrose in a crystallized form in order to have it available for food purposes therefore would appear to entail an unnecessary loss of labor and expense. This, however, is but one of the numerous arguments in favor of manufacturing sucrose into syrup instead of commercial sugar for many household purposes.

High grade granulated sugar, generally speaking, is chemically pure sucrose for it has a purity of upwards of 99.9 per cent. Moreover it has only the sweet flavor common to the chemical sweet "saccharine" and practically none of the delicate flavor and pleasant odor which made the rich Demerara crystals famous a few decades ago. This came from the film of rich syrup surrounding the crystals. In the process of refining sugar all of this syrup adhering to the crystals of sucrose is removed and becoming a by-product, while, as mentioned before the delicate flavor of the sugar is thereby impaired.

Normal cane juice contains from five-tenths per cent to two per cent or more of invert sugar, commonly known as glucose. This means that from eight to forty pounds of invert sugar are contained in the juice from each ton of cane. This invert sugar has exactly the same composition and is equally as good as that resulting from the inversion of sucrose by the enzyme of the human system, even though it has not gone through

that synthetical process required for the cane to unite the two molecules into the new substance—sucrose.

It is not to be presumed that all sacchariferous products should be used only in the form of syrup, for they are more bulky to transport; special containers are required for them; and greater precautions must be taken to prevent them from deterioration from bacterial action not to mention the fact that such do not always meet the desire of fastidious consumers who demand sweets that are snow white and crystalline in appearance rather than those with the rich golden color and the delicate flavor nature herself has given them.

There are a great variety of syrup made commercially. These are derived from numerous sources among them being the sugar cane (*Saccharum officinarum*), sweet sorghum (*Andropogon sorghum*), sugar maple (*Acer saccharum*), and sugar producing palms including *Arenga saccharifera, Phœnix sylvestris, Nipa fructicans,* and *Borassus flabelliformis.* It has been recommended that syrup be made from sugar beets also, but due to the composition of the impurities contained in the juice of beets which consists largely of compounds that are unpleasant to the taste, the sugar beet has not received much attention as a source of syrup.

CANE SYRUP

This syrup consists of the juice of the sugar cane boiled to the required consistency after receiving proper clarification, the degree of which depending upon the condition of the original juice. Where high grade cane of a light color that has grown to full maturity under favorable conditions is employed, and light pressure only is used in extracting the juice so that only a minimum amount of impurities are removed from the cane, practically no attention need be given to clarification.

There is, however, a wide difference in the purity of cane juices, some containing as high as 94 per cent of the total solids in the form of sucrose, while others have as low as 50 per cent or less. The higher purity ordinarily indicates close proximity to maturity of the cane while the extremely low purity may be the result of several causes, among them being poor varieties of cane, under maturity, overmaturity, unfavorable growing conditions, windstorms, and injury by animals, insects or parasitic plants. The low purity of a cane juice, however, may not always indicate an extremely low yield in syrup, though there is usually some diminution; nor does it always give a syrup of an inferior quality. But it may give

A field of uba or Japanese cane which has been used extensively as a source of syrup

a syrup with an entirely different flavor and other characteristics, since a portion of the crystallizable sucrose will usually be changed into invert sugar, and the composition of some of the nonsugar may also have been effected. It has been recommended by some syrup makers that this class of cane be used in preference to ripe cane in order to make a syrup in which the sugar will not crystallize, but this difficulty may readily be overcome in another manner which will be set forth later, and thus the change in other organic compounds may be avoided.

Some varieties of cane are of a higher color than others. These usually give a light colored juice and in consequence usually a lighter syrup, especially when but little attention is given to clarification. This is one of the reasons why D 74 became so popular among syrup producers. The coloring substance "anthocyan" is ordinarily not all removed by the limited amount of lime used in clarification; but that remaining is not readily bleached by the sulphitation. It is therefore usually better to reject the darker varieties of cane when high grade syrup is desired.

In the manufacture of fancy table syrup, only selected cane which is thoroughly ripe should be used. A high extraction of the mill is not recommended since undesirable amounts of organic impurities are thus removed with the juice, which will cause a darker syrup with an inferior flavor. The juice from the rolls should be thoroughly strained to remove any large particles of bagasse or cane and other impurities, then treated with a small quantity of milk of lime to precipitate some of the organic impurities and while it is boiling any light impurities that rise to the top should be completely skimmed off. After this treatment it is either at once left to settle or first treated with sulphur dioxide gas.

Sometimes, however, this sulphuring of the juice is done before the lime is added. The sulphuring has the effect of raising the acidity of the juice so that more lime may be added to effect clarification. It also serves as a bleaching agent, making a brighter syrup, and causes the precipitation of some of the impurities. Care must be exercised that not too much of the sulphur gas be used, since an undersirable quantity of sulphites that might remain in the syrup would be harmful. It is essential that the juices be left to stand for sufficient time to permit the impurities to settle to the bottom, leaving only the clear supernatant liquor above.

The clarified liquor which remains above the impurities should have a dear amber or straw color when it is ready for evaporation. If there are still appreciable amounts of impurities present, the juice should be carefully filtered through bags while the settlings from the subsiders may be filtered through presses and this filtrate clarified with the original juice.

Where a high grade syrup for direct consumption is made, this work of concentration is always done in open train evaporators under atmospheric pressure, since the highly desired aromatic flavors are thus preserved, while in the vacuum type of evaporator these flavoring substances which are quite volatile, would escape with the vaporized water as a result of the reduced pressure. The more modern design of open evaporator for this work has a steam space usually in the form of coils in the bottom of the evaporator, which contains the steam for heating.

Plate XII shows a view of a steam heated evaporator.

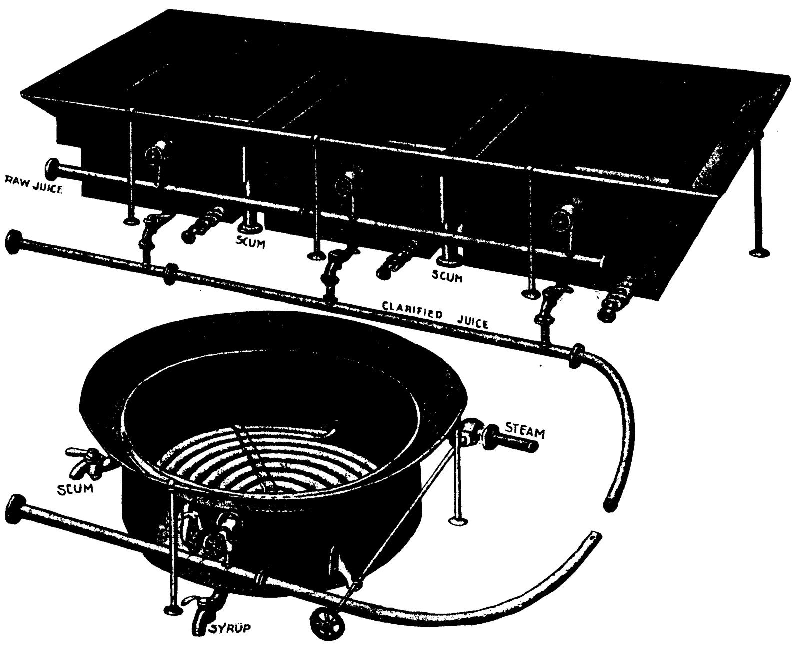
Water under atmospheric pressure at sea level boils at a temperature of 212° F, but when there is a quantity of sugar and other solid material present the boiling point will be materially increased, the extent of increase depending upon the density of the solution. At the higher temperature there is a noticeable amount of the sucrose inverted or changed into glucose, but this causes little harm to the resulting syrup so long as no caramel or burned sugar is produced by superheating.

Where the juice is boiled in kettles by the application of direct flames, as is done in some very small factories, there is always more or less caramel formed which is responsible for the bitter taste and dark color of many syrups; but where modern steam heated evaporators are employed there is no danger of this trouble occurring.

In order to make high grade table syrup of a light color and good flavor the juices should not come in contact with iron, for the acids of the juice combine with iron forming dark colored products that are impossible of removal without destroying the delicate flavor desired in the syrup. For this reason copper apparatus should be used as both containers for the juice and evaporators.

It should be borne in mind that the quality of the finished syrup will determine to a great extent the price it will bring when thrown on the general market. This is determined largely by three different conditions of the syrup namely the *body, color* and *flavor.*

A point of very great importance in the manufacture of high grade table syrup is the consistency to which the syrup is to be



A view of a steam heated evaporator

boiled. This condition is often referred to by dealers as "body" and is usually judged quite accurately without the aid of instruments, by men of experience. However, in the manufacture of high grade syrup one should not be content with any "hit or miss" method in determining the density of his product, but should use a gravity spindle either Baumé or Brix. By the aid of the following table these results may be transferred readily from the one to the other.

If the syrup is boiled to 39° or 40° Baumé (73° Brix or solis), it will ordinarily meet the requirements of most dealers. By the aid of the following table these results may be readily transferred from one scale to the other.

Degree Baumé.	Degree Brix.	Degree Baumé	Degree Brix.
1	1.8	26	46.8
2	3.6	27	48.7
3	5.4	28	50.5
4	7.1	29	52.5
5	8.9	30	54.3
6	10.6	31	56.2
7	12.4	32	58.1
8	14.2	33	60.0
9	15.9	34	61.9
10	17.7	35	63.8
11	19.5	36	65.8
12	21.3	37	67.7
13	23.1	38	69.7
14	24.9	39	71.8
15	26.7	40	73.7
16	28.6	41	75.6
17	30.3	42	77.7
18	32.1	43	79.7
19	33.9	44	81.8
20	35.7	45	83.9
21	37.6	46	86.0
22	39.4	47	88.1
23	41.3	48	90.2
24	43.1	49	92.3
25	45.0	50	94.0

SORGHUM SYRUP

The ordinary sweet sorghum yields a juice containing a high percentage of sugar that can be made into a most excellent syrup if properly handled.

There is a great quantity of this syrup often called molasses made in the United States each year, nevertheless the production could well be increased for it does not by any means meet the demand. Sorghum is a short growing crop that is somewhat better suited to cool climates than warm. A remarkably large amount of sugars are stored up by a small area grown to this crop. It is true that the greater amount of this is invert sugars, but as mentioned before if these are pure and have been properly handled, they are just as wholesome as sucrose and have the special advantage of being in a form one step nearer to that form required for their assimilation than sucrose.

The juice of sorghum contains non-sugars that give a rather strong flavor to the syrup especially if it has been boiled to a heavy density and consequently heated to a high temperature. It is customary in making this syrup on a small scale in the little mills throughout the country to concentrate the juice as soon as it comes from the mill without preliminary clarifying treatment. It has been proved that a much purer syrup and one with a milder and more delicate flavor can be made if the juice is properly treated with such clarifying reagents as lime, phosphoric acid and sulphur dioxide.

The finished syrup should be handled in the same manner as cane syrup.

If a producer is careful in the making of his syrup and manufactures a superior article, put up in attractive containers, he can build up an exclusive trade which will look for his brand and accept no other.

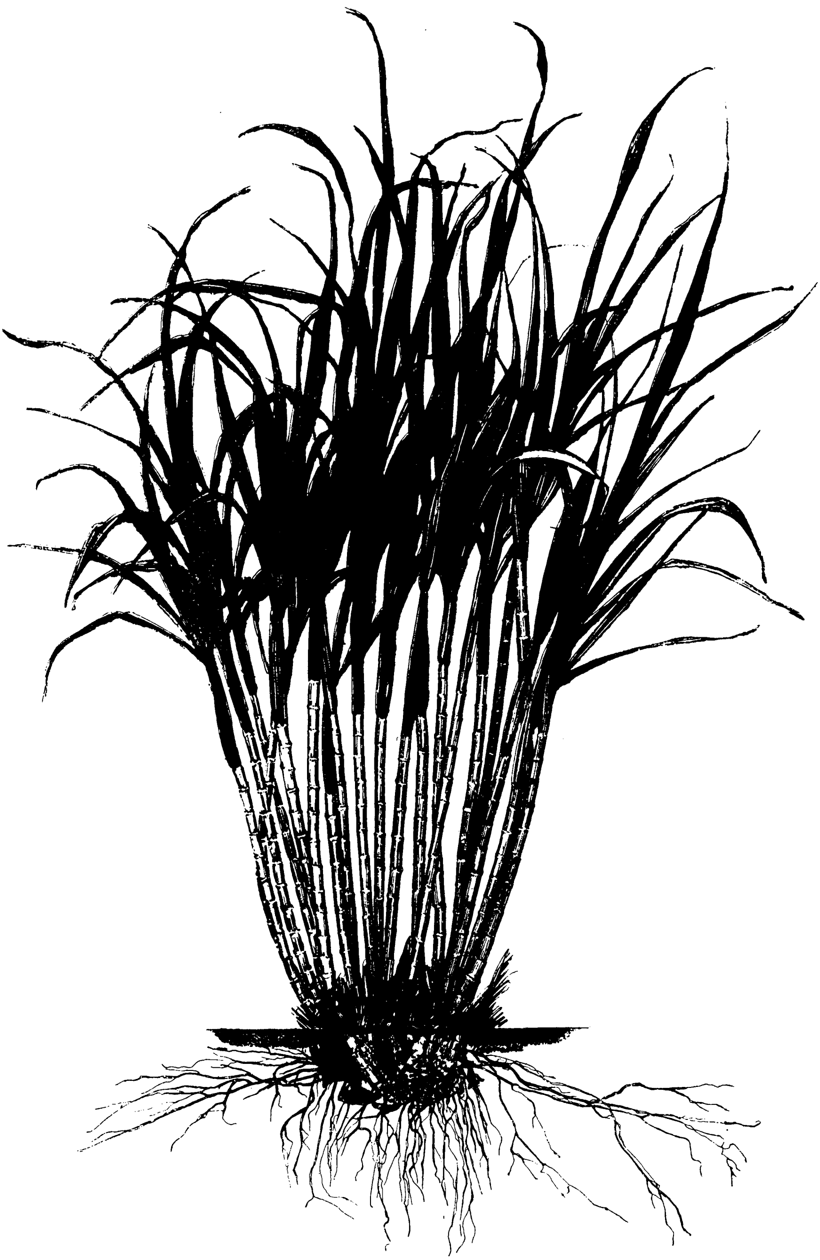
PALM SYRUP

The sap which flows through the flower stem of a number of tropical palms contains a high percentage of sugars and some of them also contain non-sugars that lend a pleasant flavor to the finished syrup, but it has been observed in boiling the sap from certain palms that the pleasant flavor is liable to give way to others that are rather disagreeable to the taste if the temperature is too high. This is because the produces decompose when the non-sugars are overheated.

Syrups have been made from the sap of palms by the natives of tropical countries from time immemorial. These were of a very dark color and were made by merely heating the sap over direct fires until sufficiently concentrated to meet the requirements; but where syrups are made for the trade and must be stored for a long time it is necessary to subject the original sap to preliminary clarification and to guard as far as possible against overheating.

Absolute cleanliness during every stage of the work is necessary and special attention should be given to prevent fermentation of the saps before boiling. This would cause the decomposition of the sucrose, which would lower the sweetening power as well as to cause a change in some of the impurities that would impair the flavor of the final syrup.

In collecting the sap only clean and thoroughly sterilized containers made of non-corrosive metal, porcelain or the like should be used and these should be provided with a cover to prevent foreign substances from entering. Since the saps from the



Stool of Sugar Cane

majority of the sacchariferous palms are usually subject to enzymic action, every possible means of minimizing this trouble should be employed. In the first place, there should be a regular time for gathering the sap and extreme care exercised that it be not left to stand any longer than necessary without special treatment. Usually not more than four to six hours should elapse between the collections of sap and even then some form of germicide should be used to prevent fermentation. While a number of different chemicals will answer for this purpose, the most suitable one for ordinary circumstances is formalin. An apparatus may very easily be arranged so that a few drops could be admitted from time to time during the flow of the sap. Calcium hydroxide, or calcium sulphate, may also be mixed very advantageously for this purpose and this would have the additional advantage of aiding in the clarification and precipitation of the impurities.

MAPLE SYRUP

The work of preparing for the "sugar run" is started during the winter so that everything may be in readiness to take advantage of the freezing and thawing weather which causes the sap to flow at the break of spring. Just as cane syrup must be made at a specific season of the year, during which the sugars are stored up so maple syrup must be made at certain definite time in order to take advantage of the rising of the sap from the root system of the tree at the beginning of spring. The sap of the maple contains a low percentage of sucrose as well as invert sugars, consequently a great deal of water must be evaporated to reduce it to the syrup state.

The sap from the tree is gathered twice each day—morning and evening—and as soon as it reaches the sugar house it is carefully strained through cloth and deposited in clean covered storage tanks to await concentration. The apparatus originally used for this work of concentration consisted of a series of kettles the boiling juice being dipped from one to the other of these kettles until it reached the desired degree of concentration when it was "finished" in one kettle used specially for that purpose. In modern sugar houses this work is done in galvanized iron or better still in copper apparatus containing compartments so the juice may flow from one to another by gravity during concentration. These apparatus are heated by steam instead of direct fires common in the old system, thus minimizing the conversion of sucrose into glucose by inversion, or worse still into other decomposition products among them

being caramel. The presence of such material in maple syrup and also various foreign impurities that enter during the process through which it passes during manufacture are largely responsible for the different grades and various flavored syrups found on the market.

The quality of this syrup is judged by the critical eye and keen taste of syrup merchants in the same manner as cane syrup is judged. As mentioned before both the color and flavor in the manufacture of maple syrup are determined largely by cleanliness and close attention to details in the various processes through which the syrup passes. Little can be done in clarifying this juice and removing the impurities by means of chemical reagents without impairing the delicate flavor common to maple products.

The density to which the syrup is boiled is entirely under the control of the manufacturer and this is an important factor. The specification generally demanded is that the syrup be sufficiently concentrated as to weigh 11 pounds to the gallon. When such syrup is boiled in the open air at sea level it has a temperature of appoximately 215° F. Instead of using a Brix or Baumé spindle in determining the correct time to stop boiling the syrup it is customary among those making syrup on a small scale to determine the time to stop boiling by the temperature of the boiling mass.

The finished syrup either should be left to stand in a deep tank for the heavy impurities to settle to the bottom, or it should be filtered through flannel while boiling hot.

Careful attention must be given in sealing the syrup in suitable containers for it is important that it should not ferment. The hot method of putting up the syrup is usually best to insure this since the containers are thus made perfectly sterile. But there seems to be more danger of the sucrose crystallizing out and thus impairing the quality of the syrup it is made at all heavy.

GLUCOSE SYRUP

There are various syrups on the market consisting almost entirely of commercial glucose or a combination of the various invert sugars. These make most excellent foods when properly manufactured; that is when either only a small amount of the chemical used as an inverting agent is left or it is subsequently removed before the syrup is placed on the market.

The ratio of sweetness of glucose (dextrose) to sucrose is usually considered to be approximately as 2 to 3; i. e., it is only two thirds as sweet as sucrose.

GLUCOSE SYRUP FROM STARCH

The syrup is sold under various trade names and in America is quite often called "corn syrup." The main reason for its receiving this name is that the starch from corn is sometimes used in its manufacture. In Europe the starch from potatoes and rice is also used for this purpose. There is no essential difference in the syrup made from these starches, except in the details of manufacture. The principle used in the making of this syrup is to boil the starch with a powerful acid, such as sulphuric or hydrochloric, which exerts a hydrolytic effect upon the starch, splitting it up into its component parts and thus producing commercial glucose. This glucose includes several of the monose sugars and should not be confused with the chemical substance known as glucose or "dextrose" which is but one of the constituents of commercial glucose. In recent years hydrochloric acid has been used extensively as the inverting reagent since the precipitate which forms after the use of sulphuric acid, as formerly employed, gives the syrup a cloudy appearance unless it is entirely removed which is a difficult task.

With many persons there is a prejudice against the glucose syrups because of the fact that glucose is a prepared compound and is largely used as an adulterant in preserves and other delicacies for the more expensive sugar-sucrose. If these syrups have been properly made and no foreign matter admitted, they make very good food, but they always contain a certain amount of chemicals used in decomposing the starch. While glucose has not an unpleasant taste, at the same time it would not appeal to the palate unless given some artificial flavor, for this reason, each factory making this class of substance usually turns out a syrup with a peculiar flavor calculated to enhance its popularity. It is often customary, although not essential, to give the syrup also an attractive color as well.

GLUCOSE SYRUP FROM SUCROSE

As mentioned before sucrose is easily split up into the two invert sugars, dextrose and levulose with only an infinitesimal amount of the inverting agent. Consequently the trifling amount of impurity left in the syrup will do no harm, and where sugar containing a film of rich golden syrup around the crystals, such as a good grade of 96 test sugar, or the famous Demerara crystals are used a syrup may be made with the characteristic cane flavor and rich golden color so much desired.

The International Confectioner is the authority for the fol-

lowing simple instructions for conducting the inversion process in making high grade glucose syrup.

"Cane or beet sugar (sucrose) can be inverted by the simple process of heating in the presence of an acid. The following formula may be used in making invert sugar syrup.

100 lb. of sugar
44 lb. of water
50 grams of powdered tartaric acid.

"These ingredients are mixed together and boiled for 30 to 35 minutes. If boiled longer than 35 minutes the syrup darkens in color and a flavor develops which tends to make the syrup resemble glucose syrup, and this is somewhat undersirable. This solution boils at a temperature of 220° Fahr.

"The above formula should make 100 lb. of syrup, and if there is considerable loss due to evaporation, the syrup can be brought up to this weight by the addition of water. The resultant invert sugar syrup is not unlike strained honey in appearance and taste. It contains about 71.4 per cent of sugar and it tastes considerably sweeter than a sugar syrup of the same strength and it does not crystallize."

ROOT SYSTEM OF CANE SUGAR

By C. W. Hines, *Sugar Technologist*

In order to grow any plant which produces a great amount of foliage and cellular tissues it is necessary that there be formed a large and well developed root system. It is no doubt true that a limited amount of moisture is absorbed through the stomata of the leaves, but by far the greater amount is taken up by the roots, and it is through this means that dissolved plant food materials, including various gasses, reach the tissues of the plant. In the case of sugar cane the inorganic and some of the organic elements are used in building the plant tissues but the substance sucrose sought for in the production of this plant is derived entirely from the carbon dioxide, a gas found in the air and in the pores of the soil, and from water. It is obvious then that the root system performs very important functions for the plant.

The root system of sugar cane is unlike that of the majority of plants as it consists of no large tap root and branching from all sides the various smaller roots, but on the contrary it consists of numerous club-like stems known as rhizomes.

These vary in length from less than an inch to several inches. In thickness and shape they are also irregular. The individual rhizomes consist of nodes and the internodes are much shorter, thus giving many more nodes to a given length than are present in the stalk. Since each node contains a bud, or an eye, as they are often called, that is capable of producing at least one new stalk and often many, if it happens that new rhizomes are formed at the base of the new stalk, there is a possibility of an almost indefinite number of stalks being produced. Many of the buds in the old rhizomes remain dormant and never develop stalks. Yet nature has made a very wise provision to have them in readiness for the development of larger stools where favorable growing conditions obtain. There is never any danger of all of these buds developing into stalks at the same time, however rich the land may be, for in that case the stalks would grow so thick as to retard the growth allowing them to develop into stalks no larger than large grasses like the original ancestors of the sugar cane found growing in the rich alluvial valleys of the Ganges of India and along the rivers of Negros where the "Tigbao Mestiza" is found.

Again, nature permits only a limited number of the buds to develop stalks in these soils which are somewhat deficient in plant food elements like those in Pampanga, Bulacan and Rizal Provinces which have been constantly cropped to sugar cane year after year for a very long time without the return of the plant food elements promptly removed and the plowing under of organic matter.

Plate XV shows a view of a planter who has long neglected his land, endeavoring to increase the number of stalks by passing a harrow over the young growing cane which breaks down the stalks and induces several buds in the rhizomes to develop into stalks. If there is not enough plant food elements present in an available form and there is insufficient organic matter to make the soil into a good physical condition, it is impossible to grow large canes even from the few buds nature saw fit to develop; hence the extra number induced by this treatment must only result in smaller canes.

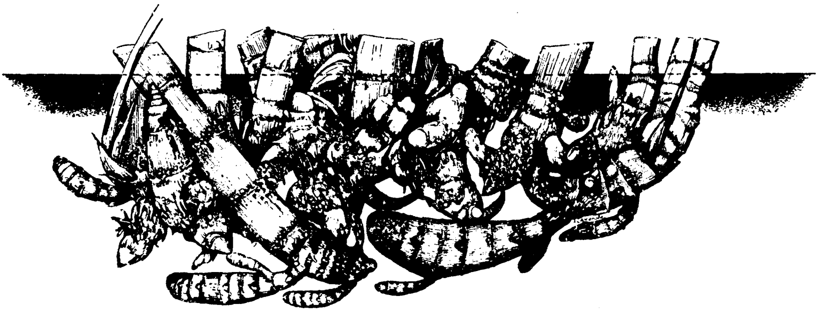


Fig. 6. Rhizomes of a stool of sugar cane with the small roots removed

It is true that some varieties of cane produce larger root systems than others and again some develop more stalks than others even in a root system of equal size. Those are said to be good ratooning varieties. It should be borne in mind, however, that the "ratooning characteristic" depends more upon the condition of the soil than it does upon the particular variety and the so called "poor ratooning varieties" may be made to ratoon well if the soil is in proper condition.

Branch roots.—The plant food material is not absorbed by the stems themselves, but instead by branch roots extending from them in all directions. These terminate in very delicate porous roottips which absorb the plant food dissolved in water and dissolve it to feed the root stems and the above-ground portion of the plant. These roots sometimes extend two meters

or more from the plant if there is plenty of plant food material available in the soil to feed the plant; if the soil is in the proper physical condition to permit the roots to penetrate it and if proper growing conditions can be obtained. It is true that the cane grower can not control all of these conditions, but he can control the majority of them. If the soil has been robbed of its organic matter by having all plant substances burned off each year, thereby not only destroying the tilth but also causing a loss of the much needed nitrogen, he can rotate his cane crop with leguminous crops, the latter of which he should plow under just before maturity is reached. If the land has been robbed of plant food material year after year for generations, he can add these in the form of fertilizers. If it is a clay soil that is firm and heavy so that the roots cannot well penetrate it, in many cases he can greatly improve this by making heavy applications of lime in the carbonate form and perhaps smaller ones in the oxide or hydroxide form, and in addition he should stir up the subsoil before the cane is planted.

Plant food material must be in a dissolved form before it can be used by the plants. The lower stratum of the soil is always moist however dry the upper soil may be; but the roots cannot penetrate it and take advantage of this moisture during the long dry periods unless it is properly broken up. It is a good practice to follow each furrow with a deep subsoiler when the land is being plowed for the first time for plant cane, and then again to pass the subsoiler down the newly formed furrows before the cane is planted. In addition to the above mentioned advantages derived from subsoiling, the cane will withstand storms better due to the larger and stronger root system that is formed, hence less work will be required in harvesting the straight standing cane thereby.

Care of the ratoon canes.—In harvesting, the cane should be cut at the level of the ground or indeed slightly beneath the surface of the ground. If for any reason it is cut higher the field should be gone over with a "stable shaver" set to cut the cane slightly below the surface of the ground.

The dirt should then be loosened up near the stools and if possible removed and replaced with another from between the furrows. If fertilizers are to be applied, the first application should be made during this process. In case irrigation water is available the land should be well soaked up at this time and just as soon as the surface is dry enough it should be broken up and made into a fine mulch for the purpose of conserving the

moisture in the soil. From this time on the same treatment should be given the ratoon cane as is given plant cane.

Rhizones for transplanting.—Where plant material in the form of cuttings is scarce, the rhizomes may be transplanted to other fields and equally as good results may be expected in the production of crops from cuttings, provided proper attention is given them. In preparing this material no harm will be done by cutting and breaking away the old branch roots or even by breaking off some of the rhizomes from each stool. In fact it is recommended that the stools be parted and portions containing two or three rhizomes be planted in each hill.

After the stools are plowed out they should be stored in a damp place until they are to be planted, unless the land can be irrigated, in which case the water should be turned on soon after planting is finished.

Only well prepared land should be used for them and the planting should be conducted in exactly the same manner as that of the points. The planting should be done in furrows approximately twenty centimeters deep and the rhizomes need have but a shallow covering of earth to begin with, but more earth should be thrown over them with each application of irrigation water.

Planting sugar cane using an ordinary plow for furrowing out

Breaking down young sugar cane by means of a bamboo harrow in order to induce a greater number of stocks to develop in each stool

DISEASES, INSECTS, AND PLANT PESTS OF THE SUGAR CANE IN THE PHILIPPINE ISLANDS

By C. W. HINES, *Sugar Technologist*

There are numerous pests of the sugar cane in every tropical country where the plant is found. In some countries these pests are less troublesome than in others, either because they do not thrive quite so well under certain conditions or because parasites are present which serve to hold them in check. Among the pests found here the ordinary cane borer (*Diatraea saccharalis*) is the most common. It is found in practically all parts of the Archipelago, but it does not damage the cane here as greatly as it does in many other countries. This is no doubt due to the fact that it is held in restraint by one or more of the parasites also found here. The various fungus enemies of plants which are often said to cause diseases of sugar cane here in the Philippines have been studied to some extent by Professors Baker, Reinking and Banks, a brief of their report follows:

Puccinia Kuehnii (Krueg) Butl., the sugar cane rust. This attacks the leaves, and, while far from rare, is not known to do really serious damage here. It must, however, be regarded as of economic importance.

Ustilago Sacchari Rabh, the sugar cane smut. This attacks young canes and is occasionally found in cane fields, in which it is quite destructive. It may be controlled easily by burning all diseased shoots, and taking care in planting to use only healthy tips.

Bakerophoma Sacchari Diedicke. This fungus produces spots on the midrib and at the base of the blade of the leaf. Although first discovered a year or two ago, it is very common in this vicinity and is probably present in all sugar cane sections of of the Islands. It lowers the vitality of the plant but does not destroy it.

Cercospora. There are several species of this genus on sugar cane in the Philippines. All produce leaf spots, which are found common in Laguna Province and all other sugar producing districts and countries. It lowers the vitality of the cane without killing it.

Phyllachora Sacchari Henn, is another fungus which does not seem at present to be of economic importance, but which, judging by the behavior of its relatives, might easily become so.

Meliola Arundinis Pat. is a fungus parasite of our cane which is unlikely ever to do damage of import.

Apiospora Camtospora Penz. et Sacc. *Coniosporum extremorum* Syd. and *C. vinosum* (Berk. et Curt.) Sacc. are fungi commonly found on dead leaves of cane which may possibly encroach on living tissue, or have some connection with fungi starting on living leaves.

Of rind diseases, there are probably several. *Melanconium Sacchari* Cooke, which is the cause of the best known rind disease of canes elsewhere, is rather common here in poorly kept fields. Either close planting or lack of cultivation and consequent low vitality may result in the practical destruction of a crop by this fungus.

Of fungi attacking the roots, *Dyctyophora phalloidea* and a *Marasmius* are found here; both are recognized as enemies in Hawaii, and the latter is widely feared.

With regard to the fungous diseases of Philippine sugar cane in general, it may be stated that they do extensive damage, but that the extent of this is very largely due to the prevalence of exceedingly close planting of the cane and to the very general absence of proper cultivation. The effectiveness of good cultivation in decreasing damage by these diseases is very well illustrated by the relative immunity of fields on the Calamba Sugar Estate, as compared with the many relatively uncultivated fields in the same neighborhood.

SUGAR CANE PLANT PARASITE

Among the various pests of sugar cane in the Philippines there is none which does so much damage in very short time once it enters the field as the *Argineta indica*. This is a parasite plant which grows on the roots of sugar cane and various other plants and belongs to the broom rape family. It is widely distributed not only over the entire Archipelago, but also over many of the various other islands and the East Indies.

The plant attains a height of from 15 centimeters to 25 centimeters and there are always a number of stalks where it is found at all.

It bears a purple flower at the top and but a few days are required from the time the flower is produced until that particular stalk matures and dries up ready to scatter a new supply of seed over the ground. The seeds are very small.

The writer has observed it growing in cane fields in Laguna, Rizal, Batangas, and on the Island of Negros, but always on lands in ratoon cane that had been poorly cultivated.

Parasitic plant of sugar cane (Argineta indica)

Field of sugar cane attacked by parasitic plant (Argineta indica)

Stools of sugar cane attacked by the parasitic plant (Argineta indica)

The best remedy that can be recommended to combat this plant is through cultivation and although the plant usually appears when the cane is mature or nearing maturity, shallow cultivation by hoeing may be given infested regions and care should be exercised to see that no stems are allowed to develop above the ground. It would be disastrous to any cane were this plant allowed to develop on its roots even though left only a short time for the cane could not be used for milling purposes.

The writer has observed cane normally given juices with a purity of 86 within two weeks reduced to below 60 purity. In addition to this loss of sucrose the decomposition products formed within the cane as a result of the plant feeding upon its stored up food supply are of a peculiar, bitter nature, making the cane entirely unfit for milling.

Dr. Merrill, Director of the Bureau of Science, gives the following report on this plant:

"In reference to your letter of January 12th, the stool of sugar cane from Cabuyao is parasitized with the plant technically known as *Argineta indica* Linn., a common Indo-Malayan representative of the broom rape family. This species occurs normally on the roots of certain wild grasses and in some places is very abundant in the Philippines, notably so in parts of the Mountain Province. It has been reported from various parts of India and to me previously from Laguna Province as a pest in sugar cane fields.

The plant is a true parasite, containing no chlorophyl and taking its entire food and water supply from the host on which it grows. On ratoon cane wherever it occurs in abundance it must of necessity decrease the yield of sugar, although no exact data is available as to the extent of the damage that it does.

The parasite once established on the root system of the sugar cane will remain active so long as the particular cane is in cultivation. The only logical way of treating a heavily infested field of sugar cane would be to plow and, if possible, cultivate the ground for two or three seasons with some other crop. I believe that further investigation will show that this particular plant is found abundantly on sugar cane only in old ratoon fields. The seeds are very minute, are produced in very great abundance, and in all probability retain their vitality in the soil for one or more seasons, hence, the advisability of cultivating some other crop for one or two seasons where fields have become very heavily parasitized."

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